

NEW RED PANDA EXHIBIT



MARYLAND ZOO IN BALTIMORE
1876 MANSION HOUSE DRIVE
BALTIMORE, MD 21217

PROJECT MANUAL

BKP ARCHITECTS
1525 LOCUST STREET, 5TH FLR.
PHILADELPHIA, PA 19102

CIVIL: CARROLL ENGINEERING
LANDSCAPE: RAS
STRUCTURAL: STRUCTURAL DESIGN STUDIO
MEP/LIFE SAFETY: KOVACS WHITNEY

New Red Panda Exhibit
Maryland Zoo in Baltimore

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DOCUMENT 002600 - PROCUREMENT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Procurement Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Procurement and Contracting Documents, submitted prior to receipt of bids in accordance with Instructions to Bidders.
- B. Procurement Prior Approval Requests: Requests for approval of products or manufacturers from those required by the Contract Documents as defined by product selection procedures in Section 016000 "Product Requirements."
 - 1. Procurement prior approval is required when products or manufacturers are listed in specifications under "Sole Product," "Sole Manufacturer," "Limited List of Products," or "Limited List of Manufacturers" introductory paragraphs.
 - 2. Procurement prior approval is not required when products or manufacturers are listed in specifications under "Non-Limited List of Products" or "Non-Limited List of Manufacturers" introductory paragraphs.
- C. Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Contract Documents, submitted following Contract award. See the General Conditions and Section 012500 "Substitution Procedures" for conditions under which Substitution requests will be considered following Contract award.

1.2 QUALITY ASSURANCE

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

1.3 PROCUREMENT SUBSTITUTIONS

- A. Procurement Substitutions, General: By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Procurement Substitution Requests will be received and considered by Owner when the following conditions are satisfied, as determined by Architect; otherwise requests will be returned without action:
 - 1. Extensive revisions to the Contract Documents are not required.
 - 2. Proposed changes are in keeping with general intent of the Contract Documents,

3. including level of quality of the Work represented by requirements therein.
Request is fully documented and properly submitted.

1.4 SUBMITTALS

- A. Procurement Substitution Request: Submit to Architect. Procurement Substitution Request must be made in writing by prime contract Bidder only in compliance with the following requirements:
 1. Requests for substitution of materials and equipment will be considered if received no later than fifteen working days prior to date of bid opening.
 2. Submittal Format, Printed: Submit one electronic copy in bound PDF format, of each written Procurement Substitution Request, using Document 002601 - "Request for Substitution Form, Bidding Phase" bound in Project Manual.
- B. Architect's Action:
 1. Architect may request additional information or documentation necessary for evaluation of the Procurement Substitution Request. Architect will notify all Bidders of acceptance of proposed substitute by means of an Addendum to the Procurement and Contracting Documents.
- C. Architect's approval of substitute during bidding does not relieve Contractor of the responsibility to submit required Shop Drawings and to comply with all other requirements of the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 002600

DOCUMENT 002601 - REQUEST FOR SUBSTITUTION FORM, BIDDING PHASE

PART 1 - GENERAL

1.1 SUMMARY

- A. Prime Bidders: Use this form to request consideration of an unnamed manufacturer, an unnamed product, or an alternative fabrication method prior to submittal of bids when use of specific manufacturers, products, or fabrications methods are required by the Specifications.
- B. See Document 002600 "Procurement Substitution Procedures" for instructions for submittal of this form and for definitions used on this form.
- C. Response to this request by Architect will be in the form of a written response to the Bidder and, if approved, by Addendum issued to all Bidders.

1.2 PROJECT INFORMATION

- A. Project Name: New Red Panda Exhibit.
- B. Project Location: Maryland Zoo in Baltimore.
- C. Owner: Maryland Zoo in Baltimore.
- D. Architect: BKP Architects.

1.3 BIDDING REQUEST INFORMATION

- A. Bidder: _____.
- B. Email: _____.
- C. Specification Section No.:
_____.

1.4 SPECIFIED PRODUCT

- A. Specified Product/Fabrication Method (List Name, Description, Model Number, and Manufacturer):
_____.
- B. Specified Product Information (Attach Point-by-Point Data to This Form):

1. Point-by-point comparative product data.
2. Test reports.
3. Fabrication drawings.
4. Samples (where applicable).

1.5 PROPOSED PRODUCT

- A. Specified Product/Fabrication Method (List Name, Description, Model Number, and Manufacturer):

_____.

- B. Proposed Product Information (Attach Point-by-Point Data to This Form):

1. Point-by-point comparative product data.
2. Test reports.
3. Fabrication drawings.
4. Samples (where applicable).

1.6 IMPACT OF PROPOSED SUBSTITUTION

- A. List of Related Changes Required by Substitution: None. Explain:

_____.

- B. Differences between Specified Product and Proposed Substitution: None. Explain:

_____.

- C. Proposed Product/Fabrication Method Effects on Other Parts of the Work: None. Explain:

_____.

- D. Proposed Product/Fabrication Method Effects on the Contract Time: None. Explain:

_____.

1.7 CERTIFICATION

- A. Undersigned certifies the following:

1. Proposed substitution has been investigated by the Bidder and determined to be equal or superior to specified product as used for this Project, except as noted herein.
2. Qualifications of manufacturer, Installer, and other specified parties meet the specified qualifications.
3. Same warranty will be furnished for proposed substitution as for specified product, if applicable.

4. Same maintenance service and availability of replacement parts as for specified product, if applicable.
5. Proposed substitution does not affect dimensions and functional clearances, except as noted herein.
6. Proposed substitution will not affect the Contract Time.
7. Proposed substitution will not affect work of other trades.

1.8 SUBMISSION OF REQUEST FOR SUBSTITUTION

A. For the Bidder:

1. Submittal Date:
_____.
2. Firm Name:
_____.
3. Submitted by:
_____.
4. Email:
_____.
5. _____.

B. For Manufacturer:

1. Submittal Date:
_____.
2. Firm Name:
_____.
3. Submitted by:
_____.
4. Email:
_____.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 002601

SECTION 006000 - PROJECT FORMS

PART 1 - GENERAL

1.1 FORM OF AGREEMENT AND GENERAL CONDITIONS

- A. The following form of Owner/Contractor Agreement and form of the General Conditions shall be used for Project:
 - 1. AIA Document A101-2017 "Standard Form of Agreement between Owner and Contractor Where the Basis of Payment is a Stipulated Sum."
 - a. The General Conditions for Project are AIA Document A201-2017 "General Conditions of the Contract for Construction."
 - 2. The General Conditions are included in the Project Manual.

1.2 ADMINISTRATIVE FORMS

- A. Administrative Forms: Additional administrative forms are specified in Division 01 General Requirements.
- B. Copies of AIA standard forms may be obtained from the American Institute of Architects; www.aiacontractdocsaicontracts.org; (800) 942-7732.
- C. Information and Modification Forms:
 - 1. Form for Requests for Information (RFIs): AIA Document G716-2004 "Request for Information (RFI)."
 - 2. Form of Request for Proposal: AIA Document G709-2018 "Proposal Request."
 - 3. Change Order Form: AIA Document G701-2017 "Change Order."
 - 4. Form of Architect's Memorandum for Minor Changes in the Work: AIA Document G710-2017 "Architect's Supplemental Instructions."
 - 5. Form of Change Directive: AIA Document G714-2017 "Construction Change Directive."
- D. Payment Forms:
 - 1. Schedule of Values Form: AIA Document G703-1992 "Continuation Sheet."
 - 2. Payment Application: AIA Document G702-1992/703-1992 "Application and Certificate for Payment and Continuation Sheet."
 - 3. Form of Contractor's Affidavit: AIA Document G706-1994 "Contractor's Affidavit of Payment of Debts and Claims."
 - 4. Form of Affidavit of Release of Liens: AIA Document G706A-1994 "Contractor's Affidavit of Payment of Release of Liens."
 - 5. Form of Consent of Surety: AIA Document G707-1994 "Consent of Surety to Final Payment."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 006000

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Contractor's use of site and premises.
4. Work restrictions.
5. Specification and Drawing conventions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: New Red Panda Exhibit.

1. Project Location: Maryland Zoo in Baltimore.

B. Owner: Maryland Zoo in Baltimore.

1. Owner's Contact: Karl Kranz.
2. Address: 1876 Mansion House Drive, Baltimore, MD 21217.

C. Owner's Representative: HDC, Inc.

1. Owner's Representative Contacts: John Mills, Kristen Mills
2. Address: 2818 O'Donnell Street, Baltimore, MD 21224

D. Architect: BKP Architects.

1. Architect's Contacts: Joseph Powell, Jon Stefansson, Crystal Collado.

E. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:

1. Civil Engineering: Carroll Engineering.
 - a. Civil Engineer's Contacts: Judy Carroll, Craig Shannon.
2. Landscape Architecture: RAS.
 - a. Landscape Architect's Contacts: Geoff Anderson, Annie Vapaa.

3. Structural Engineering: Structural Design Studio.
 - a. Structural Engineer's Contact: Jake Merkley.
4. MEP/Life Safety Engineering: Kovacs Whitney.
 - a. MEP Engineer's Contacts: Steve Jones, Matthew Robinson, Michael Holland.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
 1. Site clearing, subsurface utilities, new animal holding building, renovation of existing animal holding building, new habitats, patron viewing areas, and patron pathways. and other Work indicated in the Contract Documents.
- B. Type of Contract:
 1. Project will be constructed under a single prime contract.

1.4 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Unrestricted Use of Site: Contractor shall have full use of Project site, as identified on the Drawings, for construction operations during construction period.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- C. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.5 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 7:00 a.m. to 4:00 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 1. Notify Architect, and Owner not less than two working days in advance of

2. Obtain Architect's, and Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
1. Notify Architect, and Owner not less than two working days in advance of proposed disruptive operations.
 2. Obtain Architect's, and Owner's written permission before proceeding with disruptive operations.
- E. Smoking and Controlled Substance Restrictions: Use of alcoholic beverages, and other controlled substances on Owner's property is not permitted. Smoking by Contractor's and sub-contractor's personnel is permitted only in areas designated by the Owner. Contractor is responsible for the disposal of cigarette butts in identified containers provided by the Contractor.
- F. Employee Identification: Provide identification for Contractor personnel working on Project site in the form of easily recognizable color shirts or safety vests. Require personnel to wear identification at all times.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor and subcontractor personnel working on Project site.
1. Maintain list of approved screened personnel with Owner's representative.

1.6 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. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. 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 scheduled on Drawings and published as part of the U.S. National CAD Standard.
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 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Document 002600 "Procurement Substitution Procedures" for requirements for substitution requests prior to award of Contract.
 - 2. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
 - 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 to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying 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 form provided in Project Manual.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions 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 as well as 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.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions 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 five working days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within ten working days of receipt of request, or five working days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions 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.

1.4 QUALITY ASSURANCE

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

1.5 PROCEDURES

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

1.6 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than ten working days prior to time required for preparation

and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when all of the following conditions are satisfied. If all of 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. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.

B. Substitutions for Convenience:

1. Not allowed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
 - 2. Section 013100 "Project Management and Coordination" for requirements for forms for contract modifications provided as part of web-based Project management software.

1.2 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.3 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. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request after receipt of Proposal Request, 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, labor supervision, and project management 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 Contractor's letterhead; project management software generated proposals will not be accepted.

- B. Contractor-Initiated Proposals: 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, labor supervision, and project management 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 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 7. Proposal Request Form: Use Contractor's letterhead; project management software generated proposals will not be accepted.

1.4 CHANGE ORDER PROCEDURES

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

1.5 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.
1. 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.
1. 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 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Document 004373 "Proposed Schedule of Values Form" for requirements for furnishing proposed schedule of values with bid.
 - 2. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 3. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.2 DEFINITIONS

- A. 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.

1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with 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 ten working days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use 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. Owner's name.
 - c. Name of Architect.
 - d. Contractor's name and address.
 - e. 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. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 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.
5. 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.
6. Overhead Costs, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
7. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
8. Closeout Costs. Include separate line items for Operation and Maintenance manuals, warranty documentation, and Project Record documents under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
9. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.4 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.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Application for Payment 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 for 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.
- 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 items stored off-site.
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 2. 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.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- 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 waivers of mechanic's lien from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional 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 conditional 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 executed waivers of lien on forms 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.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Submittal schedule (preliminary if not final).
 6. List of Contractor's staff assignments.
 7. Copies of building permits.
 8. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 9. Initial progress report.
 10. Report of preconstruction conference.
 11. Certificates of insurance and insurance policies.
 12. Performance and payment bonds.
 13. Data needed to acquire Owner's insurance.
- I. Application for Payment at Substantial Completion: After Architect issues 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.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
- J. Final Payment Application: After completing Project closeout requirements, 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.
 2. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. Proof that taxes, fees, and similar obligations are paid.
 10. Waivers and releases.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
1. General coordination procedures.
 2. Coordination drawings.
 3. RFIs.
 4. Digital project management procedures.
 5. Web-based Project management software package.
 6. Project meetings.
- B. Related Requirements:
1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.2 DEFINITIONS

- A. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

- A. 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. Include the following information in tabular form:
1. Name, address, telephone number, and email address of entity 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.
- B. Key Personnel Names: Within ten working 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, 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.

1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different 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.
- B. 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 REQUEST FOR INFORMATION (RFI)

1.6 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's CAD drawings will be provided by Architect for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Digital Drawing Software Program: Contract Drawings are available in Autodesk AutoCAD 2023.
 4. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.
 - a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.
- B. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - h. Management of construction progress photographs.
 2. Provide project management software user licenses for use of Owner, Architect, and Architect's consultants.
 3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.7 PROJECT MEETINGS

- A. General: Meetings and conferences will be conducted at Project site unless otherwise indicated.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than fifteen working days after execution of the Agreement.
 1. Attendees: Authorized representatives of Owner Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. 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. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Critical work sequencing and long lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Use of web-based Project software.
 - g. Procedures for processing field decisions and Change Orders.
 - h. Procedures for RFIs.
 - i. Procedures for testing and inspecting.
 - j. Procedures for processing Applications for Payment.
 - k. Distribution of the Contract Documents.
 - l. Submittal procedures.
 - m. Preparation of Record Documents.
 - n. Use of the premises.
 - o. Work restrictions.
 - p. Working hours.
 - q. Owner's occupancy requirements.
 - r. Responsibility for temporary facilities and controls.
 - s. Procedures for moisture and mold control.
 - t. Procedures for disruptions and shutdowns.
 - u. Construction waste management and recycling.
 - v. Parking availability.
 - w. Office, work, and storage areas.
 - x. Equipment deliveries and priorities.
 - y. First aid.
 - z. Security.
 - aa. Progress cleaning.
 3. Minutes: Architect will record and distribute meeting minutes.
- C. Preinstallation Conferences: Contractor to conduct a preinstallation conference before each construction activity when required by other Sections and when required for 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 RFIs.
 - 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: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 30 working 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, 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. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Progress meetings will be conducted at biweekly intervals.
1. Attendees: In addition to representatives of Owner 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 meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. 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) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of Proposal Requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 3. Minutes: Architect will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Contractor to 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 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 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. Construction schedule updating reports.
 - 3. Daily construction reports.
 - 4. Site condition reports.
 - 5. Unusual event reports.
- B. Related Requirements:
 - 1. Section 014000 "Quality Requirements" for schedule of tests and inspections.

1.2 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 Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration.
- C. Event: The starting or ending point of an activity.

1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF 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 Applications for Payment.
- D. Daily Construction Reports: Submit at monthly intervals.

- E. Material Location Reports: Submit at monthly intervals.
- F. Site Condition Reports: Submit at time of discovery of differing conditions.
- G. Unusual Event Reports: Submit at time of unusual event.

1.4 COORDINATION

- A. 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 entities involved.
 - 2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that is capable of managing construction schedules.
- B. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
 - 1. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat separate areas as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than fifteen working days.
 - 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Construction of mock-ups, prototypes and samples.
 - d. Regulatory agency approvals.
 - e. Punch list.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 - 4. Startup and Testing Time: Include no fewer than five working days for startup and testing.
 - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 - 6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.

- 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 Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- E. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule three working days before 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 Final Completion percentage for each activity.
- F. Recovery Schedule: When periodic update indicates the Work is 14 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, equipment required to achieve compliance, and date by which recovery will be accomplished.
- G. Distribution: Distribute copies of approved schedule to Architect Owner,, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. 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.

1.6 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within five working days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in fifteen percent increments within time bar.

1.7 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 presence of rain or snow.
 6. Testing and inspection.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events.
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 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. Substantial Completions authorized.
- B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- C. Unusual Event Reports: 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, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
5. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those

corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
3. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.

1.4 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
 1. Project name.
 2. Date.
 3. Name of Architect.
 4. Name of Contractor.
 5. Name of firm or entity that prepared submittal.
 6. Names of subcontractor, manufacturer, and supplier.
 7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals. (i.e.: 033000-1.1 for initial submittal, 033000-1.2, etc. for subsequent submittals)
 8. Category and type of submittal.
 9. Submittal purpose and description.
 10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 11. Drawing number and detail references, as appropriate.
 12. Indication of full or partial submittal.
 13. Location(s) where product is to be installed, as appropriate.
 14. Other necessary identification.
 15. Remarks.
 16. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow ten working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Resubmittal Review: Allow ten working days for review of each resubmittal.
 - 3. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow fifteen working days for initial review of each submittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

- a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
3. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return one submittal set with options selected.
 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit two sets of Samples. Architect will retain one Sample set; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- E. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page

of submittal.

F. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

G. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with indication in web-based Project management software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - 1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return.
 - 1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action, as follows:
 - a. No Exceptions Taken (does not require resubmittal)
 - b. Make Corrections Noted (does not require resubmittal)
 - c. Revise and Resubmit (requires resubmittal)
 - d. Rejected
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be

returned for resubmittal without review.

- D. Architect will return without review submittals received from sources other than Contractor.
- E. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and

systems.

2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
- E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.3 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- E. Reports: Prepare and submit certified written reports and documents as specified.
- F. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan not less than five working days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
- B. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

- C. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
- D. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- E. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - 1. Name, address, telephone number, and email address of technical representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Statement that products at Project site comply with requirements.
 - 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.

5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.8 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems 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. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products 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.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups of size indicated.
 - 2. Build mockups in location indicated or, if not indicated, as directed by Architect.
 - 3. Notify Architect five working days in advance of dates and times when mockups will be constructed.
 - 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 - 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 6. Obtain Architect's approval of mockups before starting corresponding Work, fabrication, or construction.
 - a. Allow five working days for initial review and each re-review of each mockup.
 - 7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
 - 8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 10. Demolish and remove mockups when directed unless otherwise indicated.

1.9 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections not specifically identified as Special Inspection items are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor will not employ same entity engaged by Owner for Special Inspections, unless agreed to in writing by Owner.
 - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.

4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- C. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- F. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 6. Security and protection for samples and for testing and inspection equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.10 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

1. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
2. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
4. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
5. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and authorities' having jurisdiction reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore

patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within ten working days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Wood Stockade Fencing: Minimum 6 feet high, continuous stockade fencing in maximum 8 feet long sections attached to nominal 4 inch by 4 inch supporting posts set firmly in ground.
- B. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 8 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.
- C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.

2.2 TEMPORARY FACILITIES

- A. Field Offices:
 - 1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 5. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service:
 - 1. Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.
- D. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- E. Electric Power Service:

1. Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- G. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: Use designated areas of Owner's existing parking areas for construction personnel. There will be several access and parking locations available. Some access points and parking locations may need to be periodically shut down to accommodate Work phasing and Zoo events. Contractor must coordinate access to the Project Site with the Zoo's Owner's Representative. Contractor and sub-contractor personnel are encouraged to carpool.
- D. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.
- F. Waste Disposal Facilities:
1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control:
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection:
 - 1. Comply with requirements specified in Section 015639 "Tree Protection."
- F. Site Enclosure Fences: Before construction operations begin, furnish and install site enclosure fences in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fences: As illustrated on the L series of Drawings and as required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- G. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- H. Temporary Egress: Provide temporary egress around project site as indicated on the L series of Drawings and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.

2. Supervise welding operations and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor.
 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 015639 – TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the protection of trees that interfere with, or are affected in any way by, execution of the Work, whether temporary or new construction.
- B. Related Sections include the following:
 - 1. Section 312000 "Earth Moving".
 - 2. Section 311000 "Site Clearing".
 - 3. Section 311005 "Site Demolition"

1.3 DEFINITIONS

- A. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches above the ground line for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground.
- B. Tree-Protection Zone (TPZ): Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings. TPZ's are defined by a circle concentric with each tree with a radius 15" for every 1" of caliper size (DBH). Where overlapping, TPZ's are defined by a shape that extends to the outermost boundaries of each grouping of trees indicated.
- C. Special Excavation Zone:
 - 1. Areas indicated on Tree Protection and Demolition and Protection plans and may require expansion if demolition work reveals critical root zones for existing trees in areas beyond the special excavation zones.
 - 2. Removals work within a Special Excavation Zone requires the submittal of a work plan indicating means, methods, and sequencing proposed to prevent soil compaction and damage to exiting landscape trees and roots, buildings, and existing work to remain.
 - 3. Requires on-site and real-time monitoring of all removals and modifications within each designated area.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
 - a. Tree-service firm's personnel and equipment needed to make progress and avoid delays.

- b. Arborist's responsibilities.
- c. Quality-control program.
- d. Coordination of Work and equipment movement within and around the locations of protection zones.
- e. Trenching by hand or with air spade within and around protection zones.
- f. Field quality control.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Tree Protection Plan, a written report and plan prepared by Contractor and Arborist addressing, at a minimum, the following:
 - 1. Plans, elevations, sections – as required - and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with all protection zones.
 - 2. Detail fabrication and assembly of protection-zone fencing and signage.
 - 3. Indicate extent of trenching by hand or with air spade within protection zones.
 - 4. Report shall review all areas of Special Excavation as shown on plans and shall indicate all proposed measures to protect existing or exposed soil from vehicular use within these areas. Information shall include root pruning, structural and compensatory pruning, soil aeration, and fertilization as required.
 - 5. Coordinate all submittals with existing or proposed construction fence or hoarding and all points of site access. Indicate all areas along site access routes where pruning of overhanging limbs may be required. Include complete schedule as per below.
 - 6. Itemized tree inventory of all trees to be protected on-site. A numerical replacement value shall be provided for each tree and subject to Owner approval.
- C. Samples: For each type of the following:
 - 1. Organic Mulch: 1-quart volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For arborist and tree service firm.
- B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
 - a. Tree protection plan to include the following information:
 - 1) Tree protection fencing locations
 - 2) Silt fencing (to be coordinated with sediment and erosion control plans)
 - 3) Root pruning lines
 - 4) Root protection matting zones
 - 5) Mulching zones
 - 6) Tree pruning plan noting:
 - 7) Root pruning areas/trees
 - 8) Canopy thinning/reduction areas/trees
 - 9) Canopy lifting areas/trees
 - 10) Tree/stump removals
 - 11) Understory cleaning areas
 - 12) Maintenance schedule
 - b. Construction activities zone plan to include the following information:
 - 1) Construction and staging zones
 - 2) Construction access points and routes
 - 3) Designated materials storage areas
 - 4) Concrete and masonry storage and wash-out areas
 - 5) Demolition access and dumpster storage areas
 - 6) Soil stockpiling
 - 7) Equipment staging, storage, and access areas
 - 8) Limits of disturbance
 - 9) Excavation depths
 - 10) Benching
 - 11) Tree removals and replacements

E. Quality-control program.

1.7 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA – minimum 10 years in-field experience.
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

- a. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection zone fencing and signage, the arborist's and tree-service
- C. firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.
- D. Tree pruning standards: Comply with ANSI A300, "Trees, Shrubs and Other Woody Plant Maintenance – Standard Practices", and the "Standards of Shade Trees", current edition, as published by National Arborist Association, The Meeting Place Mall, Route 101, PO Box 1494, Amherst, NH 03031-1094.

1.8 FIELD CONDITIONS

- A. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material
 - 2. Moving or parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digs unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
 - 8. Excessive wetting from runoff or drainage.
 - 9. Spillage of construction materials hazardous to vegetation.
 - 10. Felling of trees into tree protected areas.
 - 11. Trenching operations.
- B. Do not direct vehicle or equipment exhaust toward protection zones
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

1.9 SEQUENCING AND SCHEDULING

- A. After review and approval of Tree Protection Plan submitted by Contractor and Arborist, install tree protection prior to any and all site removals, including tree removals.
- B. Landscape Architect shall review and approve tree protection devices installation prior to start of removals work.
- C. Perform tasks related to the trees at time appropriate to best horticultural and arboricultural practices as established in Tree Protection Plan.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
 - 1. Type: Shredded hardwood bark or wood and bark chips.
 - 2. Size Range: 3 inches maximum, 1/2 inch minimum
 - 3. Color: Natural.
- B. Pruning Alcohol
 - 1. Commercial ethyl alcohol or "Ethanol" 70-95
- C. Anti-desiccant: "Wilt-Pruf NCF" anti-desiccant by Wilt-Pruf Products, Inc., "Cloud Cover" by Easy Gardener", or approved equal conforming to the following:
 - 1. 100% organic and biodegradable, and not damaged by freezing.
- D. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements:
 - 1. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch (50-by-100-mm) horizontal rails and vertical posts, spaced not more than 96 inches (2400 mm) apart, and lower rail set halfway between top rail and ground.
 - a. Height: 48 inches minimum or as shown on the drawings.
 - 2. Wood Snow Fence: Consisting of uniformly spaced hardwood slats woven together with a minimum five two wire strands of galvanized wire; secured to wood frame with UV-stable plastic bands or galvanized-steel or stainless-steel wire ties;
 - a. Height: 48 inches.
 - b. Color: Natural, no staining.
- E. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz. /sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
- F. Plywood- For use in selected areas within root-zones of specimen trees.
- G. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes pre-punched and reinforced; legibly printed with non-fading lettering and as follows:
 - 1. Size and Text: 8-1/2 inches by 12 inches minimum. Text to read "Tree Protection Zone" or as directed by Owner's Representative.
 - 2. Lettering: 1-inch-high minimum, black characters on white background.
 - 3. Signage to be provided by Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

- B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.
- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.
 - 1. Apply 2-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.

3.3 ARBORIST

- A. Supervise the installation and placement of landscape protection fencing
- B. Oversee the protection of trees throughout the course of the project.
- C. Coordinate with Owner's Arborist throughout project duration. Notify Architect immediately of any damage or root zone conflicts.

3.4 PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
- B. Maintenance of Protection-Zone Fencing: The contractor shall be responsible for the repair and replacement of any part of new or existing protective fencing throughout the duration of the project.
- C. Where construction work is required within the branch spread of trees that are to remain, the work shall be performed under the direction of the Arborist.
- D. Geotextiles: Prescribed for designated trees where foot traffic, masonry debris, or surface equipment can impact critical root zone yet access is needed for construction. Triple ply geotextile is tacked on top of mulch buffer beneath and removed upon completion. This method should be used extensively for staging, stockpile, and access within tree protection areas.
- E. Mulching – For select specimen or tree protection zones requiring traffic access install a 12" layer of wood chips overlaid with continuous 3/4" plywood sheets on the existing grade for the entire area of the traffic route to allay rutting and slightly reduce soil compaction.
- F. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 20 feet on protection-zone fencing, but no fewer than four signs with each facing a different direction.
- G. Maintain protection zones free of weeds and trash.

- H. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.
 - 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 - 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 3120 00 "Earth Moving" unless otherwise indicated.
- B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.
- D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.6 ROOT PRUNING

- A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:
 - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 - 2. Cut Ends: Coat cut ends of roots more than 1-1/2 inches (38 mm) in diameter with a coating formulated for use on damaged plant tissues and that is acceptable to arborist. Cover with wet burlap and maintain moist.
 - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 4. Cover exposed roots with burlap and water regularly.
 - 5. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."
- B. Root Pruning at Edge of Protection Zone: Prune tree roots flush with the edge of the protection zone by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.7 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Owner. Replacement value of trees shall be that which was established based on value in Arborist's report.
- B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition or are damaged during construction operations that Owner determines are incapable of restoring to normal growth pattern.
 - 4. Small Trees: Provide new trees of same size and species as those being replaced for each tree that measures 4 inches or smaller in caliper size.
 - 2. Large Trees: Provide two new tree(s) of 3-inch caliper size for each tree being replaced that measure more than 4 inches in caliper size.
 - 3. Plant and maintain new trees as specified in Section 329300 "Plants."
- C. Excess Mulch: Rake mulched area within protection zones, being careful not to injure roots. Rake to loosen and remove mulch that exceeds a 2-inch 4-inch Insert dimension uniform thickness to remain
- D. Soil Aeration: Where directed by Landscape Architect or Owner, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches OC. Backfill holes with an equal mix of augured soil and sand.
- E. Post-Construction – Remove protective fencing, wood chips, debris and all surplus construction materials from site following construction, in a manner that will not damage tree preservation areas as directed by Owner. Re-seed, re-sod, or refurbish all disturbed ground areas as soon as possible to the satisfaction of Owner.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 015639

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SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 2. Section 017700 "Closeout Procedures" for submitting warranties.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluating Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with Division 01 requirements regarding substitutions" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 - 2. Data indicating compliance with the requirements specified in "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is inconspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
 - 3. See individual identification Sections in Divisions 22, 23, 26, 27, and 28 for additional equipment identification requirements.

1.4 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.
- C. Storage:
 - 1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
 - 2. Store products to allow for inspection and measurement of quantity or counting of units.
 - 3. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections are to be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. **Manufacturer's Warranty:** Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Owner or endorsed by manufacturer to Owner.
 - 2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of Owner or endorsed by manufacturer to Owner.

- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
 - 6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by Architect, whose determination is final.
- B. Product Selection Procedures:
 - 1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
 - 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

- a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
 4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product

matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.
- B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within five working days of receipt of a request for a comparable product. Architect will notify Contractor of approval or rejection of proposed comparable product within ten working days of receipt of request, or ten working days of receipt of additional information or documentation, whichever is later.
1. Architect's Approval of Submittal: Marked with approval notation from Architect's action stamp. See Section 013300 "Submittal Procedures."
 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017117 – ANIMAL MANAGEMENT REQUIREMENTS OF CONSTRUCTION

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Animal Management requirements of construction are indicated at various areas of the Construction Documents. These requirements are general in nature and indicate universal type details required to be constructed as part of the Base Contract Price for this Project. Inclusive of the requirements, the General Contractor (GC), all subcontractors and all sub-subcontractors shall, as part of the Base Contract, do the following:
1. Hide all conduits, pipes, water lines, cables, utility lines, etc. or other loose construction at the minimum distance indicated in the Contract Documents, to avoid animal contact. Where this is not possible, the specified guard plates, or other protective devices shall be installed at no additional cost to the Base Contract Price.
 2. Animals have been known to injure themselves due to items left in holding or exhibit spaces during construction. Each contractor is responsible for regularly removing all construction debris in compliance with this requirement for work in his/her area including, but not limited to nails, screws, wire, wood, metal scraps, welding rods, and other small fasteners or miscellaneous items.
 3. Provide the special animal management requirements of construction wherever required as shown in the drawings or written into these Specifications.
- B. The intent of these requirements is to ensure that the Owner obtains a facility in which Zoo personnel and animals may interact safely for the betterment of the entire facility. These requirements are not intended to cover all conditions that may arise during construction and the General Contractor shall cooperate with the Maryland Zoo in Baltimore designated staff, and Architect/Landscape Architect during the construction period.
- C. The General Contractor shall recognize that this facility is of unique construction and shall at all times take precaution to minimize the use of the Animal Management requirements as much as possible by thorough coordination of all the sub-trades involved, and through coordination of placement of all Work prior to installation throughout the Project, to minimize contact with animals on exhibit throughout the Zoo.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide the materials shown in the drawings and notes where conditions require their respective use. See A or CG series of Drawings for cover plates. Other shapes, not shown, might be required to accomplish the intended goal of animal protection.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install all required items and/or perform all required work to create uniform and consistent conditions to the requirements of the Animal Management notes and details. This includes small, medium, and large indoor holding spaces and exterior yards.

END OF SECTION 017117

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering.
 - 3. Installation.
 - 4. Cutting and patching.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.

- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting surveys.
 - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 PREINSTALLATION MEETINGS

- A. Layout Conference: Conduct conference at Project site.
 - 1. Prior to establishing layout of new perimeter, review building location requirements. Review benchmark, control point, and layout and dimension requirements. Inform Architect of scheduled meeting. Require representatives of each entity directly concerned with Project layout to attend, including the following:
 - a. Contractor's superintendent.
 - b. Professional surveyor responsible for performing Project surveying and layout.
 - c. Professional surveyor responsible for performing site survey serving as basis for Project design.

2. Review meanings and intent of dimensions, notes, terms, graphic symbols, and other layout information indicated on the Drawings.
3. Review requirements for including layouts on Shop Drawings and other submittals.
4. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.
- B. Certificates: Submit certificate signed by land surveyor, certifying that location and elevation of improvements comply with requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Final Property Survey: Submit electronic copy in CAD and PDF formats, showing the Work performed and record survey data.

1.6 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Plumbing piping systems.
 - b. Mechanical systems piping and ducts.
 - c. Control systems.
 - d. Communication systems.
 - e. Fire-detection and -alarm systems.
 - f. Conveying systems.
 - g. Electrical wiring systems.
 - h. Operating systems of special construction.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction

elements include but are not limited to the following:

- a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Equipment supports.
 - d. Piping, ductwork, vessels, and equipment.
 - e. Noise- and vibration-control elements and systems.
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.
 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other

conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections. (Corrections to be made at no additional cost to the Owner.)
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish limits on use of Project site.
 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show site improvements and utilities, existing improvements and significant vegetation, adjoining existing conditions, and grade contours.

3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb, and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Coordinate installation of anchorages. 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.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

3.6 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
- B. Temporary Support: Provide temporary support of Work to be cut.
- C. Protection: Protect in-place construction during cutting and patching to prevent damage.

Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold waste materials more than seven days during normal weather or three

- days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 - B. Site: Maintain Project site free of waste materials and debris.
 - C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
 - D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
 - E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
 - F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
 - G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."
 - H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
 - I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
 - J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work of this Section includes administrative and procedural requirements for the following:
 - 1. Recycling nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.

1.2 DEFINITIONS

- A. CMU: Concrete masonry units.
- B. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- C. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- D. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- E. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully remove in a manner to prevent damage and promptly return to Owner.

1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work. Plan must include the following:

1. Strategies to reduce the generation of waste during Project design and construction.
2. Waste diversion goals for Project, identifying the materials (both structural and nonstructural) targeted for recycling and identifying the target diversion percentage (at least 70 percent).
3. Where materials will be taken, including expected diversion rates for each material.

1.5 INFORMATIONAL SUBMITTALS

- A. 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.
- B. 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.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "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 each contractor and 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.

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan in accordance with requirements in this Section. Plan must include provisions for waste identification, waste reduction work plan. 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 and construction waste generated by the Work 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 Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
2. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
3. 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 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of at least 70 percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in 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. CMU.
 - f. Stone.
 - g. Structural and miscellaneous steel.
 - h. Rough hardware.
 - i. Roofing.
 - j. Insulation.
 - k. Doors and frames.
 - l. Door hardware.
 - m. Equipment.
 - n. Plumbing fixtures.
 - o. Piping.
 - p. Supports and hangers.
 - q. Valves.
 - r. Mechanical equipment.
 - s. Electrical conduit.
 - t. Copper wiring.
 - u. Lighting fixtures.
 - v. Electrical devices.
 - w. Switchgear and panelboards.
2. Construction Waste:
 - a. Lumber.
 - b. Wood sheet materials.
 - c. Wood trim.
 - d. Metals.
 - e. Roofing.

- f. Insulation.
- g. Piping.
- h. Electrical conduit.
- i. 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) Wood pallets.
 - 8) Plastic pails.
- j. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:
 - 1) Paper.
 - 2) Aluminum cans.
 - 3) Glass containers.

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 entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. 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 and recycled.
 - 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 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 to accrue to Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials in accordance with 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 maximum extent practical in accordance with 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. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving Recycling: Break up and transport paving to asphalt-recycling facility.
- B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
- C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
- D. Metals: Separate metals by type.
- E. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- F. Conduit: Reduce conduit to straight lengths and store by material and size.

3.4 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 Cutoffs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

3.5 DISPOSAL OF WASTE

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

1. Unless 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:

1. Do not burn waste materials.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Section 017900 "Demonstration and Training" for requirements to train Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
 5. Submit testing, adjusting, and balancing records.
 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of ten working days 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 017900 "Demonstration and Training."
 6. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 8. Complete final cleaning requirements.
 9. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of ten working 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. Results of completed inspection will form the basis of requirements for Final Completion.

1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list will state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 working 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. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS

A. Organization of List: 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, listed by room or space number.
2. Organize items applying to each space by major element, including categories for ceilings, 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.

4. Submit list of incomplete items in the following format:
 - a. MS Excel Electronic File: Architect will return annotated file.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranties in Paper Form:
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. 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

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
 - i. Vacuum and mop concrete.
 - j. Clean transparent materials. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - q. Clean strainers.
 - r. Leave Project clean and ready for occupancy.

- C. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 CORRECTION OF THE WORK

- A. Complete repair and restoration operations required by "Correction of the Work" Article in Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 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 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.2 DEFINITIONS

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

1.3 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 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 one paper copy.
- C. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. 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. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. 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. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
4. 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.

1.5 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 to 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 Architect.
 7. Names and contact information for major consultants to the Architect that designed the systems contained in the 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 in accordance with ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.6 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. Water leak.
 - 4. Power failure.
 - 5. Water outage.
 - 6. System, subsystem, or equipment failure.
- 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.

1.7 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. Required sequences for electric or electronic systems.
 8. 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.

1.8 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. 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.
- I. 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.

1.9 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 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 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 017300 "Execution" for final property survey.
 - 2. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
- 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.
- 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.

1.3 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: 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 provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be

- difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- 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. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

1.4 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. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

B. Format: Submit record specifications as annotated PDF electronic file.

1.5 RECORD PRODUCT DATA

A. 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.

B. 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.

1.6 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 scanned PDF electronic file(s) of marked-up miscellaneous record submittals.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 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.

1.2 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit one electronic copy within five working days of end of each training module.
 - 1. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.3 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- B. Videographer Qualifications: A professional videographer who is experienced in photographing demonstration and training events similar to those required.

1.4 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.

1.5 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 is 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. Required sequences for electric or electronic systems.

- I. 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.

1.6 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 017823 "Operation and Maintenance Data."

1.7 INSTRUCTION

- A. 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.
- B. 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 ten working days' advance notice.
- C. 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.

1.8 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera.
1. Submit video recordings on CD-ROM or thumb drive.
 2. File Hierarchy: Organize folder structure and file locations in accordance with Project Manual table of contents. Provide complete screen-based menu.
 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged in accordance with Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- B. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- C. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.
- D. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017900

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.

1.2 DEFINITIONS

- A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
 2. Furnish in largest practicable sizes to minimize number of joints.
 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
- B. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class.
1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

2.3 RELATED MATERIALS

- A. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- B. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 2. Form release agent for form liners to be acceptable to form liner manufacturer.
- C. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
 2. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

- D. Construct forms tight enough to prevent loss of concrete mortar.
 - 1. Minimize joints.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
 - 1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 - 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 - 1. Provide and secure units to support screed strips
 - 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 - 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 - 2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Space vertical joints in walls as indicated on Drawings.
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
 - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.

2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
 - O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
 - P. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF 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.
 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 3. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

- A. 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. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
 1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
 1. Align and secure joints to avoid offsets.
 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 INSTALLATION OF SHORING AND RESHORING

- 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. 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.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing agency to perform quality control tests and inspections.
- C. Inspections:
1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.
- D. Prepare test and inspection reports.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

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

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

- a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

- 1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Mechanical Splice Couplers: ACI 318 Type 2, same material of reinforcing bar being spliced;
- D. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Galvanized.

2.3 FABRICATING REINFORCEMENT

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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 1. Do not cut or puncture vapor retarder.
 2. 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 reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 1. Stagger splices in accordance with ACI 318.
 2. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions and as indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths.
 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

- A. 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.
 2. Continue reinforcement across construction joints unless otherwise indicated.
 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform quality control tests and inspections and to submit reports.
- C. Inspections:
 1. Steel-reinforcement placement.
 2. Steel-reinforcement mechanical splice couplers.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Vapor retarders.
5. Fiber-composite wall connectors.
6. insulation.
7. Curing materials.
8. Accessories.
9. Repair materials.
10. Concrete mixture materials.
11. Concrete mixture class types.
12. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
4. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.

- b. Independent testing agency responsible for inspections and acceptance testing of concrete at Project site.
- c. Ready-mix concrete manufacturer.
- d. Concrete Subcontractor.

2. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction joints, control joints, isolation joints, and joint-filler strips.
- c. Semirigid joint fillers.
- d. Vapor-retarder installation.
- e. Fiber-composite wall connectors and integral insulation installation.
- f. Anchor rod and anchorage device installation tolerances.
- g. Cold- and hot-weather concreting procedures.
- h. Concrete finishes and finishing.
- i. Curing procedures.
- j. Forms and form-removal limitations.
- k. Shoring and reshoring procedures.
- l. Floor and slab flatness and levelness measurements.
- m. Concrete repair procedures.
- n. Concrete protection.
- o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
- p. Protection of field cured field test cylinders.
- q. Distribution of test reports.

1.4 ACTION SUBMITTALS

A. Product Data:

- 1. Portland cement.
- 2. Fly ash.
- 3. Silica fume.
- 4. Natural or other pozzolans.
- 5. Aggregates.
- 6. Ground calcium carbonate and aggregate mineral fillers.
- 7. Admixtures:
 - a. Include limitations of use. Admixtures that do not comply with reference ASTM International requirements must be submitted with test data for approval.
- 8. Vapor retarders.
- 9. Fiber-composite wall connectors.
- 10. insulation.
- 11. Curing materials.
- 12. Joint fillers.
- 13. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

- 1. Mixture identification.

2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Maximum w/cm ratio.
5. Calculated equilibrium and fresh density for lightweight concrete.
6. Slump or slump flow limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Intended placement method.
10. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Vapor retarders.
5. Fiber-composite wall connectors.
6. insulation.
7. Joint-filler strips.
8. Repair materials.

C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.
- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties on behalf of the Architect/Engineer.
1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level 1. Testing agency laboratory supervisor tests to be an ACI-certified Concrete Laboratory Testing Technician, Level 2.
- D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
1. Personnel conducting field tests on plastic concrete properties are to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with policies from ACI CPP 610.1 or an equivalent certification program.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 as follows:
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 2. When air temperature has fallen to or is expected to fall below 40 deg F during the protection period, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 3. Do not use frozen materials or materials containing ice or snow.
 4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
- C. Note that time of concrete placement is entirely dependent upon the Contractor and in accordance with his Project Completion Schedule. If concrete is to be placed during cold- or hot-weather conditions as defined by ACI, there will be no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Source Limitations:

- 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
- 2. Obtain each type of admixture from single source from single manufacturer.

- B. Cementitious Materials:

- 1. Portland Cement: ASTM C150/C150M, Type I or Type V, gray as per General Structural Notes.
- 2. Pozzolans: ASTM C618, Class C or F.

- C. Normal-Weight Aggregates:

- 1. Coarse Aggregate: ASTM C33/C33M, Class 3M
- 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
- 3. Fine Aggregate: ASTM C33/C33M.
- 4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to applicable requirements for the class of concrete.

2.3 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C260/C260M.

- B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride.

- 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
- 2. Retarding Admixture: ASTM C494/C494M, Type B.
- 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
- 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
- 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
- 6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.

- C. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602/C1602M. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602/C1602M.

2.4 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class C: ASTM E1745, Class C; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
 - 1. 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:
 - a. ISI Building Products
 - b. Stego Industries, LLC
 - c. Tex-Trude
 - d. Viaflex

2.5 FIBER-COMPOSITE WALL CONNECTORS

- A. Basis of Design: Provide TL-series fiber-composite connectors as manufactured by Thermomass.

2.6 INSULATION

- A. Extruded polystyrene (XPS) Rigid Foam Insulation.
 - 1. Basis of Design: Foamular 250 as manufactured by Owens Corning.
 - a. ASTM C578, Type IV, 25psi minimum compressive strength.

2.7 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 - 1. Color:
 - a. Ambient Temperature Below 50 deg F (10 deg C): Black.
 - b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
 - c. Ambient Temperature Above 85 deg F (29 deg C): White.
- C. Water: Potable water that does not cause staining of the surface.

2.8 ACCESSORIES

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.9 CONCRETE MIXTURE MATERIALS

- 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, in accordance with 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 or hydraulic cement in concrete assigned to Exposure Class F3 as follows:
 - 1. Fly Ash or Other Pozzolans: 25 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
 - 1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
 - 2. Use permeability-reducing admixture in concrete mixtures where indicated.

2.10 CONCRETE MIXTURE CLASS TYPES

- A. Class A: Normal-weight concrete used for building and exhibit mast footings.
 - 1. Exposure Class: ACI 318 As indicated in General Structural Notes.
 - 2. Minimum Compressive Strength: As indicated in General Structural Notes at 28 days.
 - 3. Maximum w/cm Ratio: As indicated in General Structural Notes.
 - 4. Slump Limit: 4 inches, plus or minus 1 inch for concrete.
 - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cementitious materials.
- B. Class B: Normal-weight concrete used for foundation walls.
 - 1. Exposure Class: ACI 318 As indicated in General Structural Notes.
 - 2. Minimum Compressive Strength: As indicated in General Structural Notes at 28 days.
 - 3. Maximum w/cm Ratio: As indicated in General Structural Notes.
 - 4. Slump Limit: 4 inches, plus or minus 1 inch
 - 5. Air Content:
 - a. Exposure Class F1: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 - 6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- C. Class C: Normal-weight concrete used for interior slabs-on-ground.
 - 1. Exposure Class: ACI 318 As indicated in General Structural Notes.
 - 2. Minimum Compressive Strength: As indicated in General Structural Notes at 28 days.
 - 3. Maximum w/cm Ratio: As indicated in General Structural Notes.
 - 4. Slump Limit: 4 inches, plus or minus 1 inch for concrete.
 - 5. Air Content:

- a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Class G: Normal-weight concrete used for building frame members.
1. Exposure Class: ACI 318 As indicated in General Structural Notes.
 2. Minimum Compressive Strength: As indicated in General Structural Notes at 28 days.
 3. Maximum w/cm Ratio: As indicated in General Structural Notes.
 4. Slump Limit: 4 inches, plus or minus 1 inch for concrete.
 5. Air Content:
 - a. Exposure Class F1: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 6. Limit water-soluble, chloride-ion content in hardened concrete to [0.15 percent by weight of cement.
- E. Class H: Normal-weight concrete used for building walls.
1. Exposure Class: ACI 318 As indicated in General Structural Notes.
 2. Minimum Compressive Strength: As indicated in General Structural Notes at 28 days.
 3. Maximum w/cm Ratio: As indicated in General Structural Notes.
 4. Slump Limit: 4 inches, plus or minus 1 inch for concrete.
 5. Air Content:
 - a. Exposure Class F1: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish delivery ticket.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 - 1. Daily access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
 - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 TOLERANCES

- A. Comply with ACI 117.

3.4 INSTALLATION OF 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.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

3.5 INSTALLATION OF VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
 - 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 - 2. Face laps away from exposed direction of concrete pour.
 - 3. Lap vapor retarder over footings not less than 6 inches, sealing vapor retarder to concrete.
 - 4. Lap joints 6 inches and seal with manufacturer's recommended tape.
 - 5. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 - 6. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damaged area by 6 inches on all sides and sealing to vapor retarder.

3.6 INSTALLATION OF FIBER-COMPOSITE CONNECTORS AND INSULATION

- A. Install fiber-composite connectors through insulation, to connect and bind vertical concrete foundation walls. Install both in accordance with manufacturer's instructions.

3.7 INSTALLATION OF CAST-IN-PLACE CONCRETE

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
 - 1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 - 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
 - 1. If a section cannot be placed continuously, provide construction joints as indicated.
 - 2. Deposit concrete to avoid segregation.
 - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. 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.
- E. Deposit and consolidate concrete for floors in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Do not place concrete floors and slabs in a checkerboard sequence.
 - 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 3. Maintain reinforcement in position on chairs during concrete placement.
 - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 5. Level concrete, cut high areas, and fill low areas.
 - 6. Slope surfaces uniformly to drains where required.
 - 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
 - 8. Do not further disturb slab surfaces before starting finishing operations.

3.8 INSTALLATION OF JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 - 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Form keyed joints as indicated on Structural Drawings. Embed keys at least 1-1/2 inches into concrete.
 - 4. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
 - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints:
 - 1. Install dowel bars and support assemblies at joints where indicated on Drawings.
 - 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.9 APPLICATION OF FINISHING FLOORS AND SLABS

- A. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighnten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered by a thin-film finish coating system..
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
 - a. Slabs on Ground:
 - 1) Specified overall values of flatness, FF 35; and of levelness, FL 25; with minimum local values of flatness, FF 24; and of levelness, FL 17.

3.10 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117, Class D.
 - e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.
2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/4 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117, Class B.
 - e. Locations: Apply to concrete surfaces or to be covered with a coating material applied directly to concrete.

3.11 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.

2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
 3. 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 troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 6 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
 3. Minimum Compressive Strength: 4000 psi at 28 days.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3.12 APPLICATION OF CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
1. Comply with ACI 301 for cold weather protection during curing.
 2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
 3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305R, before and during finishing operations.
- B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
1. Cure formed concrete surfaces, including underside of beams.
 2. If forms remain during curing period, moist cure after loosening forms.
 3. If removing forms before end of curing period, continue curing for remainder of curing period as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing

period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 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.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following not in cold weather:
 - a) Water.
 - b) Continuous water-fog spray.

3.13 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 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 in excess of 0.01 inch spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids

more than 1/2 inch in any dimension to solid concrete.

- a. Limit cut depth to 3/4 inch.
- b. Make edges of cuts perpendicular to concrete surface.
- c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
- d. Fill and compact with patching mortar before bonding agent has dried.
- e. 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 matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and match surrounding surface.
3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
 - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and

level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
 8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
 - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. 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.

3.14 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform quality control tests and inspections and to submit reports.
 1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
 2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.

- 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.
 - 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.
 - 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
 - 13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at seven days and 28 days.
4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.
- C. Delivery Tickets: comply with ASTM C94/C94M.
- D. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 150 cu. yd. or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M:
 - a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests as needed.
 3. Slump Flow: ASTM C1611/C1611M:
 - a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each

- concrete mixture.
 - b. Perform additional tests as needed.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; .
 - a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
 5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample when strength test specimens are cast.
 6. Concrete Density: ASTM C138/C138M:
 - a. One test for each composite sample when strength test specimens are cast.
 7. Unit Weight: ASTM C138/C138M density of fresh structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture. The fresh density should be consistent with that associated with the equilibrium density within a tolerance of plus or minus 4 lb/ft.³.
 8. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and standard cure two sets of four 6 inches by 12-inches or 4-inch by 8-inch cylindrical specimens for each composite sample.
 9. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of four standard cured specimens at seven days and one set of two specimens at 28 days.
 - b. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 10. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 11. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
 12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 13. Additional Tests:
 - a. Testing and inspecting agency to make additional tests of concrete when

test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

- b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

- 1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.

- 14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.15 PROTECTION

- A. Protect concrete surfaces as follows:

- 1. Protect from petroleum stains.
 - 2. Diaper hydraulic equipment used over concrete surfaces.
 - 3. Prohibit use of pipe-cutting machinery over concrete surfaces.
 - 4. Prohibit placement of steel items on concrete surfaces.
 - 5. Prohibit use of acids or acidic detergents over concrete surfaces.

END OF SECTION 033000

SECTION 033712 - EXHIBIT ROCKWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work in this section shall be performed by an approved Exhibit Rockwork Contractor, as defined in this Section, and include all labor, materials, and equipment to excavate, rough grade, finish grade and fabricate the work under this contract which includes the following features as illustrated on the drawings and the Exhibit Rockwork Theming and Pages.

1. Exterior Shotcrete Fabrications of highly natural appearance, including, but not limited to the following:
 - a. Artificial geology, landform, and a structure including pool, stone walls, exterior building stucco, tree stumps, and flagstone flat work.
2. Coloring, dying, tinting of new shotcrete rockwork required achieving the required finish.
3. Coordination with other contractors for installation of hot-rocks, cooling stumps and animal drinkers.
4. Natural stone boulders used in the exhibit and public areas
5. Waterproofing of pool and waterfalls.
6. All theme painting as shown on natural boulders, rockwork and pavement.

- B. Delegated Design:

1. Provide Engineering calculations and professionally sealed drawings by a licensed engineer within project site jurisdiction for all work involving structural reinforcing.

- C. Related Requirements:

1. Division 03 Section "Shotcrete" for additional shotcrete criteria covering rockwork specified in this section.
2. Division 05 Section "Structural Steel Framing" for welding criteria.
3. Division 23 and 26 Section "Mechanical and Electrical:" Required field coordination of all piping, plumbing, and electrical (including ground wire system) with work of this Section.
4. Division 31 Section "Site Clearing:" Excavating, filling and backfilling, compaction, and grading.
5. Exhibit Rockwork Theming Pages. For examples of highly naturalistic appearances.

1.3 DEFINITIONS

- A. Approved Exhibit Rockwork Contractor: Contractor whose proven experience, qualifications, and methods have been reviewed and accepted for the Work of this Section by BKP, SDC LLC. and/or the Owner after submitting the required information indicated under the Quality Assurance paragraph of this Section.
- B. Artificial Geology and stone walls (rockwork) Definition: Shall consist of the construction and placement of the artificial features indicated on the Drawings and Specifications herein.
- C. Carved or Embossed Shotcrete: Shall consist of premixed fine aggregate and cement and water pneumatically placed or applied by suitable mechanism. Texture shall be by hand carving and embossing.

1.4 QUALITY ASSURANCE – EXHIBIT CONTRACTOR

- A. Experience and Qualification of Bidders: The Exhibit Rockwork Contractor, in order to qualify as a specialty skilled craftsman for the exhibit rockwork fabrication under this Work, shall demonstrate experience in:
 - 1. Specializing in the artistic construction of animal exhibit concrete work.
 - 2. Managing projects of this size and complexity.
 - 3. Coordination of this Work with other trades that affect this Work.
 - 4. Employing qualified and experienced crafts persons / and artists and meeting the following criteria in section 1.4B.
- B. The Exhibit Rockwork Contractor shall submit the following with the bid:
 - 1. A signed statement of experience certifying that the Contractor is an established business with a minimum of 5 years of experience and indicate in detail his experience in successfully constructing items described in paragraph 1.2.
 - 2. Photographic proof and reference material for evaluation of experience and ability to perform under this Work, including photographs (at least five (5) 8 1/2" x 11" color photographs of previous comparable work) to show the Contractor's capabilities to construct the above mentioned items for natural habitat exhibits and stone walls similar to those shown on the drawings, Contractor also to include a list of completed projects and references which demonstrate these capabilities. These projects and photographs of projects must have been the work of those craftsman and artist proposed for this work.
 - 3. Full documentation of the Construction crew, including resumes of lead personnel (on-site supervisor, and final texturing and finish experts, et al) lists of specific personnel to be used, and details of each listed person's experience and abilities to perform all phases of construction under this Work to the Architect's satisfaction. The assigned project on site supervisor and aesthetic coordinator's resume should show a minimum of four (4) years' experience in the management of project crews of no less than five persons, as well as experience in coordination with other trades in the completion of simulated rockwork fabrication projects under the Work.
- C. The following is a nonrestrictive list of pre-qualified Exhibit Rockwork Contractors, subject to compliance with the requirements of these specifications. Contractor may submit alternate

Exhibit Rockwork Contractor but must obtain pre-qualification prior to bid with design team and owner:

1. Cemrock Landscapes, Inc. / attn: Chris Conley
4798 S. Julian Avenue,
Tucson AZ 85714
(520) 571-1999
2. Cost of Wisconsin, Inc. / attn: Jack Beatty
Corporate Headquarters
4201 County Road P
Jackson, Wisconsin 53037
(262) 677-6060
3. Nassal Company, / attn: Melissa Ruminot
415 W. Kaley Street
Orlando, FL 32806-3942
(407) 648-0400
4. Paradise Labs
Baltimore, MD
5. DreamScape Designs/attn.: Stephanie Tommasello
Baltimore, MD
949-735-7122

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Contractors wishing to be approved for Shotcrete and/or artificial rockwork fabrication under this work may independently make application directly to the Architect as detailed above.
- C. The Architect/Exhibit Designer may require additional information and may request a visit to completed work in order to make a determination of the Contractor's qualification to produce exhibit artifacts with the required criteria under this Work. The Exhibit Designer may also require a submittal of a high-quality digital documentation of the completed work.
- D. The Owner and Architect reserve the right to reject non-qualified Contractors, based on qualification submittals and, at their option, review of past work and references.

1.6 INTENT

- A. It is intended that the work involved create a highly natural appearance of the above-mentioned items as shown on the Drawings and Exhibit Images.
- B. The Contractor will perform this work under the direction of the Architect and will be expected to cooperate fully in this process.

- C. The Architect explicitly reserves the right to continuously monitor the work for aesthetic quality and functional criteria of the work as it is performed.
- D. The Exhibit Contractor is responsible to see that no loose materials used in the execution of this work remain after completion of the project.

1.7 COORDINATION

- A. The Exhibit Rockwork Contractor shall fully coordinate with the other Contractors and their Contractors and the Architect. If the Exhibit Rockwork Contractor suspects that a conflict may exist between work in this Section and any other work, he/she shall bring the issue to the attention of the Architect before proceeding.
- B. Coordinate with all other trades, placement of continuous waterstops where planter construction adjoins work of other trades such as but not limited to retaining walls, building walls, and footings.

1.8 SAMPLES

- A. At least thirty days prior to beginning any exhibitry work, the Exhibit Rockwork Contractor shall deliver to the project site one 4' x 4' or other approved size sample panel for each of the rockwork and themed material types listed in the Exhibit Rockwork and Theming and Pages to the Architect for approval. The types are reiterated in the following rockwork and theming type list:
 - 1. Flagstone paving
 - 2. Stone wall
 - 3. Pool and Beach
 - 4. Mudbank
 - 5. Stucco on holding building
- B. Samples shall represent finished surfaces with texturing, coloring, etching, etc.
- C. Samples rejected by the Architect shall be resubmitted for approval by the Exhibit Rockwork Contractor at no additional cost to the Owner. Sample panels shall not be removed until the completion of the work.
- D. At the discretion of the Architect larger sample panels may be installed in their final location and used as part of the final work, if accepted.
- E. Model: Not required

1.9 ACTION SUBMITTAL

- A. All submittals shall be in accordance with - General Conditions for Submittals Division 01 Section "Submittal Procedures". The Exhibit Rockwork Contractor shall submit the following shop drawings for review:
 - 1. Layout Plan: The layout plan shall indicate and identify the following:

- a. All rockwork by indicated categories.
 - b. Locations of all required footings and foundations.
 - c. Footing and foundation types and all pertinent dimensions.
2. Steel Reinforcing: Indicate sizes, types and locations of all steel reinforcing involved in Work of this Section. Provide the seal and signature of a licensed professional Engineer within project site jurisdiction to steel reinforcement shop drawings, indicating compliance with all government codes for reinforced concrete structures. Include structural calculations for all conditions.
 3. Literature, Specifications and Mix Designs: Submit all product literature, specifications and mix designs used in the production of rockwork.
- B. Delegated-Design Submittal: For rockwork indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.10 PRE-CONSTRUCTION CONDITIONS

- A. All artificial rockwork locations shall be approved by the Architect prior to actual shotcrete application and texturing.
- B. Exhibit Rockwork Theming Pages: The Exhibit Images as provided by Architect indicates all rockwork color ranges, texture types, and respective location. For the purpose of duplicating three dimensionally the design concept and establishing the character, configuration and the amount of simulated rock to be constructed, the Exhibit Rockwork Contractor shall work from drawings and photographs furnished by the Architect/Exhibit Designer. Exhibit Images are considered part of the contract documents.
- C. Structural Reinforcement: The structural reinforcement indicated on the plans and in the specifications are to establish minimum design criteria for the Exhibit Rockwork Contractor to incorporate into the rockwork design. The Exhibit Rockwork Contractor shall be responsible to design structural reinforcement for all work in this section and shall provide a licensed structural engineer seal within project site jurisdiction certifying all structural reinforcement sections at no additional cost to the owner. Alternative methods may be recommended for greater cost efficiency. Rockwork shown on the drawings is for "order of magnitude" quantity projections. Exhibit Rockwork contractor is responsible for providing actual amounts needed within bid price.
- D. Methods of Construction: The Exhibit Rockwork Contractor shall submit with bid proposal proposed methods of construction for all work in this section. Such documentation shall include the following:
1. Statement of understanding of the overall project schedule and required completion of all rockwork and artifacts.
 2. Submit a detailed description of proposed fabrication and finish techniques (including materials) for artificial geology and alternate structural systems (if applicable). Exhibit Contractor is responsible for effective waterproofing of all water features including but not limited to all rockwork interfacing with drains, skimmers, walls, etc.
 3. Recommend additional cost effective alternative methods of construction prior to start of work for consideration by Architect and Owner.
- E. Excavation, Subdrainage and Backfill:

1. The Exhibit Rockwork Contractor is responsible for the excavation, dewatering, shoring and maintenance of all excavation, subdrainage, wall drainage and aggregate for shotcrete features up to the shotcrete subgrade.
2. The Exhibit Rockwork Contractor shall be responsible for all additional backforming and backfilling required for shotcrete work as a result of his over excavation in areas where not required. It is the Exhibit Rockwork Contractor's responsibility to avoid such over excavation and to coordinate with the General Contractor to facilitate excavation as close to final subgrade as possible.
3. The Exhibit Rockwork Contractor must accept the subgrade in written form for each individual exhibit or portion of an exhibit and submit to the Owner's Representative for approval. If not accepted, the Exhibit Rockwork Contractor must notify the Owner's Representative in writing immediately.
4. Following the acceptance of the subgrade by the Exhibit Rockwork Contractor and approval by the Owner's Representative, the Exhibit Rockwork Contractor shall be responsible for the following at no additional cost to the Owner:
 - a. All additional subgrade adjustment and reinstallation of drainage systems and sleeves required for his work.
 - b. All maintenance required to maintain the accepted subgrade, with the exception of any dewatering device which shall be the responsibility of the Site Contractor.
5. All backfill behind, around, within and on top of the shotcrete features to complete the rock simulation work to the satisfaction of the Architect shall be the responsibility of the Site Contractor in coordination with the Exhibit Rockwork Contractor.
6. Soil survey is available for reference and is not considered a part of the contract documents.

1.11 PROJECT SITE CONDITIONS

- A. Protection of Property: Take note of requirements for protection of trees and soils as specified. In particular, do not discharge cement bearing water onto the ground on site except as specifically approved by the Owner's Representative. Account for all debris generated by operations and remove from site regularly, especially small bits of reinforcement and hardware.
- B. Surveying:
 1. Provide surveying as frequently as is required to accurately locate features as detailed on drawings. Confirm location, elevations and profiles of work by optical or laser survey immediately before and after placement of each contiguous surface.
 2. Tolerance for location of any point defined on the drawings in one tenth of one foot in both horizontal and vertical dimensions.
- C. Protection:
 1. Be responsible for protection of project materials, including waterproofing susceptible to damage during forming, placing or reinforcement of shotcrete. Provide masks or remove damageable materials before beginning work.

1.12 ARCHITECT/EXHIBIT DESIGNER'S DIRECTION

- A. It is intended that the configuration, texturing and coloring for exposed shotcrete be executed under the detailed direction of the Architect/Exhibit Designer, at least until such time as satisfactory examples of the desired character have been developed. Notify the Owner's Representative at least forty eight hours before beginning placement of first example of each type of shotcrete to be exposed and schedule time when the Architect/Exhibit Designer can observe and direct the finishing work as it is executed.

1.13 TESTING SERVICE

- A. Owner will contract and pay for testing services. Exhibit Rockwork Contractor shall cooperate and coordinate testing with Owner provided testing service.

1.14 GUARANTEE

- A. Guarantee work in this section for one year from date of Final Acceptance.
- B. Repair or replace materials if there is a failure to perform as required due to failures of materials or workmanship.

1.15 PRICES

- A. Waste, Rebound and Extra Material Required for Realistic Natural Simulations: Past experience in similar zoo projects indicates that up to 25% extra concrete material (above what appears on the drawings) is or may be required to create realistic, natural simulations of the items to be provided. All bids should reflect this extra material and labor for application.
- B. Bids shall include cost of all subsurface footings and other requirements needed to complete the work.

PART 2 - PRODUCTS

2.1 ARTIFICIAL ROCKWORK (SHOTCRETE) MATERIALS

- A. Reinforcing Materials:
 - 1. Refer to Division 03 Section "Shotcrete" for requirements.
- B. Concrete Materials
 - 1. Refer to Division 03 Section "Shotcrete" for further concrete mix design requirements.

2.2 EXHIBIT ARTIFACT AND MISCELLANEOUS MATERIAL

- A. Paint shall be acrylic latex, highest quality exterior grade, matte finish.

- B. Drains: As indicated on drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. Scope:

1. Coordinate excavation and backfill with site grading contractor, allowing for use of earth face as backform where appropriate. Maintain earth grades and shapes once shotcrete work has commenced.
2. Coordinate exhibit construction in a pre-scheduled manner to allow proper access and operation with other trades.
3. Cooperate with Architect and respond to directions for the purpose of achieving the artistic effects illustrated by the contract documents and reference photos.
4. Coordinate and install exhibit elements required by this and other Sections required for a complete installation as detailed on the Drawings.
5. Finish, color and detail shotcrete construction with skill and sensitivity for the exhibit purpose, the character of the simulated landscape and the care of the animals.

3.2 TESTING REQUIREMENTS

- A. Refer to testing requirements as required in Division 03 Section "Shotcrete."

3.3 PLACEMENT OF EXHIBIT FEATURES

- A. Layout: All items shall be placed at locations on the site and grades shown on the Drawings and as directed by the Architect.

3.4 FORMING SHOTCRETE STRUCTURES

- A. At structural pool slabs, side walls, shoring and bracing wall and background concrete walls, where artificial rockwork is to be constructed, use the backup construction described below or provide the Architect/Exhibit Designer with an alternate construction system for approval.
 1. Construct an armature of metal lath on the unexposed side of the shotcrete structure as the backup construction material behind the steel reinforcing bars to which the shotcrete is applied.
 2. Metal lath shall be bent to conform approximately to the welded and steel reinforcing frame and shall be held away from the nearest bars a minimum distance of 2" min. In order to facilitate the installation of metal lath the contractor may increase the thickness of the shotcrete to do away with matching exactly the steel reinforcing outline. However, all variances from the steel outline must be approved by the Exhibit Designer.
 3. Metal lath shall be fastened to the reinforcing bars by means of tie wires or anchor spacers. Ties or spaces shall be spaced not more than 10" on center in all directions. Space lath away from reinforcing rods such that reinforcing rods will be in the center of

the finished structure. There must be a 2" minimum thickness of concrete between reinforcing bars and lath.

- B. Wherever a flash coat is to be applied to a concrete surface, the concrete surface shall be roughened texture within minimum 2" thickness. Test cores shall be taken to verify.
- C. The finish form, color and texture of the finish surface must meet with the approval and be completed to the satisfaction of the Exhibit Designer, which approval, when given, must be in writing. Contractor shall bear all costs of any and all work required to secure such approval.

3.5 PROVISIONS FOR OTHER TRADES

- A. The Exhibit Rockwork Contractor shall be responsible for coordinating of all other trades in contact with their work and Owner supplied items to fully complete the habitat setting.
- B. Provide sleeved openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, drains, cavities, and chases from trades providing such items. All non sleeved piping shall be set by the appropriate contractor except that sleeves shall be provided by the appropriate contractor and installed by the Exhibit Rockwork Contractor. Accurately place and securely support items built into forms.

3.6 STEEL REINFORCEMENT

- A. Reinforcing sizes: The Exhibit Rockwork Contractor shall develop reinforcement sizing and placement to facilitate his/her work. All structural calculations for reinforcement must be fully and clearly documented by a registered professional structural engineer, licensed in the local project jurisdiction.
- B. General:
 - 1. Clean reinforcement of loose rust, mill scale, earth, ice, and other materials which reduce bond with concrete.
 - 2. Accurately position, support and secure reinforcement against displacement by construction or concrete placement operation. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
 - 3. Notify Owner's Representative upon completion of reinforcing and prior to placing shotcrete.
- C. Minimum Standards: The following minimal steel placement standards are supplemental to the steel reinforcement notes shown on the drawings and Division 03 Section "Shotcrete." Following Shotcrete specifications if any discrepancies arise and immediately bring to Architect's attention.
 - 1. No. 3 reinforcing bars shall be placed on 10" centers both ways as the minimum acceptable amount of bar reinforcing and shall be continuous around corners. The spacing shall remain the same but the bar size will increase where, in the opinion of the Engineer, it is deemed necessary. A No. 4 bar acting as a key rod shall be placed at intersections of all plan surfaces.

2. Tack weld or wire bars where they contact or cross each other. The bars must form a rigid framework. All bars are to lap thirty (30) diameters at splices. However, a lap of 4" will be allowed if one continuous fillet weld of 3" in length is used to tie or weld the bars together at the splice. All welding to be in accordance with Division 05 Section "Structural Steel Framing." Touch up bars at welds.
3. Reinforcing bars shall be placed and bent around circles and curves, openings, corners, and angles to conform with the drawings. Bends are to be permanently shaped, not sprung into place. Particular attention shall be made to follow the outline of the stratified rock formations to eliminate excess non reinforced rockwork outcroppings
4. The tie bars and tie anchors which are exposed to air and which do NOT come in contact with any backfill material shall be given a protective covering of asphalt coating of at least one heavy coat or Rustoleum, or equal.
5. Tie bars and tie anchors which come in contact with backfill material shall be encased with a coating of shotcrete. Steel shall be covered by a minimum of 1" of shotcrete.
6. Additional #4 bars shall be used diagonally across corners of all openings, and wherever shotcrete formations act as beams additional #5 bars shall be placed at points of maximum stress, i.e., one in top and one in bottom extending 12" into supports. Additional #4 bars shall be integrated into the steel framework if such steel is necessary to provide a stable structure.
7. The mesh shall be placed on steel reinforcing on side opposite the backup material and shall be securely wired to the reinforcing bars at not less than 20" intervals in both directions. Mesh shall lap at least 2" at adjacent ends.
8. Place reinforcing for pools and slabs uniformly 1 1/2" to 2" from the bottom of shotcrete slabs.

3.7 MIXING CONCRETE

- A. Mix concrete to obtain the compressive strengths identified in Division 03 Section "Shotcrete."
- B. Mix integral color into the concrete mix to the recommendations of the color manufacturer and requirements of mix design.

3.8 PLACING CONCRETE

- A. All shotcrete shall be placed to a minimum thickness of 6", unless otherwise noted.
- B. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed.
- C. Maintain reinforcing in the proper position during concrete placement operations.
- D. Rebound: All rebound or accumulated loose aggregate shall be removed from the surface to be covered prior to placing the initial or any succeeding layers of pneumatically placed concrete. Rebound may be re used if it conforms to the requirements for aggregate, but not in excess of 25% of the total aggregate in any batch.
- E. Joints:

1. Unfinished work shall not be allowed to stand for more than 30 minutes unless all abrupt edges are tapered to a thin edge. Before resuming work, this sloped portion shall be cleaned and a bonding agent applied.
2. All construction joints in shotcrete rocks shall be tapered off to an edge. Before shooting the adjacent section the sloped portion shall be thoroughly cleaned and wetted with compressed air and water blast. No square joints will be permitted. All construction joint locations must be so positioned as to conform to the natural rock appearance as shown on the models.

F. Damage: All pneumatically placed concrete which subsides after placement shall be removed.

3.9 WATERPROOFING INSTALLATION

A. Mix waterproofing material in proportions recommended by manufacturer.

B. Apply waterproofing material in quantities by manufacturer's specified recommendations. The following minimal standards are supplemental to manufacturer's recommendations found in Division 07 waterproofing sections. Request clarification from exhibit designer on any discrepancies.

1. Apply at 90 mils thickness.
2. Apply, using stainless steel trowel, fampico brush, or appropriate compressed-air spray equipment.
3. Waterproofing material can be applied on walls in one coat by trowel or spraying up to 1/8" thickness provided the surface is immediately covered by a protection fabric, supplied by the waterproofing manufacturer.
4. If needed, such as in zones posed to movement or cracking, the waterproofing material can be additionally reinforced with a reinforcing mesh (supplied by waterproofing manufacturer), embedded between two waterproofing layers.
5. Apply only when surface and ambient temperatures are 40 – 45 degrees F. and rising. At high temperatures (i.e. 90 degrees and above) protect application from direct sun and wind to prevent premature surface shrinkage. Apply material in two coats minimum. Apply second coat within one hour.
6. Application thickness should not exceed 1/8".
7. Do not bridge cracks greater than 1/16".
8. Bridge dynamic cracks or joints with elastomeric joint sealing tape, as supplied by waterproofing manufacturer.
9. Do not overcoat waterproofing material with solvent-based materials.
10. Curing: Follow manufacturer's general instructions for curing and hardening of waterproofing material and protect surfaces from rain, frost and drying out.

3.10 FINISHES

A. The Exhibit Rockwork Contractor shall provide experts to complete the desired finishing for all work to receive a natural appearance. Such finishing and coloring shall cover all surfaces exposed to public viewing and extend at least 12" beyond view or below final backfill or grading. Architect to provide color samples as a point of beginning for painting work.

B. Carved Rockwork Formations: Artificially constructed geology and sedimentary geologic formations, as illustrated on the drawings and photographs.

3.11 CURING SHOTCRETE CONCRETE

- A. Cover and cure Shotcrete concrete as described in Division 03 Sections "Shotcrete," taking special care not to disturb special textures achieved for this work.

3.12 PLANTERS, POOLS, AND STREAMS TESTS

- A. All planters, Pools and Streams shall be filled to capacity prior to installing any finishes. Water must hold a stable level at a predetermined static water level for 48 hours. If the test as positive, finishes may be applied if the test is negative, locate and repair the leak and retest until the test is positive.
- B. Tests shall be as follows:
 - 1. 48-Hour Test Procedure: All planters, Pools and Streams will be filled to capacity following structural coat and application of waterproofing. Water must hold a stable level at a predetermined static water level for 48 hours. If the test is positive, the application of the shotcrete carving coat and subsequent finishes may be applied if the test is negative, locate and repair the leak and retest until the test is positive.
 - 2. 2-Week Test Procedure: After all shotcrete, finishes and equipment are applied and installed each planter shall be tested for leaks while the recirculation equipment is on, for a continuous time period of 2 weeks. A constant water level must be maintained during this time period. If water levels drop, locate the source of the leak, and repair as required. Retest for an additional 48-hour period with equipment turned on. Retest for 48 hours each time until the test is positive.
 - 3. Final Inspection Test Procedure: Planters are to be tested again as a condition of Final Inspection. If the test is negative, locate and repair and retest at no additional cost to Project. Repeat until tests are successful.

3.13 PAINTING

- A. Paint all exposed surfaces of shotcrete. Painting shall make exhibit artifacts look as natural as possible, using provided references photos. Exhibit Designer shall be final judge of acceptable quality of painting.
- B. In order to blend in with surrounding artificial rockwork, additional items in and around shotcrete such as, miscellaneous hardware, concrete walls, and paving segmental retaining wall, etc., are to receive matching paint finishes in order to achieve an overall uniform look.
- C. Rockwork items to be painted, including theme painted concrete and boulders should have a minimum of three different paint colors.

3.14 BOULDERS

- A. Excavate as needed, place and backfill "natural" boulders as specified, and as directed and located by the Architect/Exhibit Designers. Boulders to be theme painted to match surrounding rock.

3.15 CLEAN-UP

- A. Clean-up rebound from operations and dispose of as void fill, as structural fill more than 3' -0" below finish grade, or off-site on a daily basis.
- B. Do not leave or bury loose pieces of reinforcing, sheet or expanded metal, tie wire, plastics or any other material not fully embedded in concrete.
- C. Clean overspray and rebound from adjacent work (including natural boulders) at the completion of each day's placing (or sooner if required). Leave all surfaces broom-clean and unstained at the completion of the work.

3.16 FINAL COMPLETION

- A. Contractor shall repair and patch all punchlist items to the satisfaction of the Architect.
- B. Contractor shall carefully inspect all construction areas to remove all debris, particularly stones, steel bars, and other materials, which could be uncovered by the Animals.

3.17 INSTRUCTIONS ON OPERATIONS AND MAINTENANCE.

- 1. Schedule an on-site instructional seminar with all required Zoo personnel. Instruct for the operations, proper usage, and maintenance of all items installed.

3.18 SCHEDULE OF IMAGES: REFER TO EXHIBIT ROCKWORK PAGES

- A. The Exhibit Rockwork Theming and Pages (at the end of this spec section) identifies images for the rockwork and rockwork type adjacencies in order to give the contractor the intent of the design. These should be used as a guide for the form, texturing and transition of rockwork types. Additional images can be provided for further clarification during construction.

END OF SECTION 033712

SECTION 033713 – SHOTCRETE

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 shotcrete applied by wet-mix process.
- B. Related Requirements
 - 1. Division 03 Section "Exhibit Rockwork" for further shotcrete/rockwork requirements and waterstops used in conjunction with shotcrete.
 - 2. Division 03 Section "Exhibit Rockwork" for Geotextile Fabric and drainage mat.
 - 3. Division 07 Section "Crystalline Waterproofing" of Concrete for waterproofing of shotcrete.

1.3 DEFINITIONS

- A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
- B. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. See Division 03 Section "Exhibit Rockwork."

1.5 ACTION SUBMITTALS

- A. See Division 03 Section "Exhibit Rockwork" for additional information
- B. Product Data: For each type of product including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
- C. Design Mixtures: For each shotcrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Shop Drawings: For shotcrete installation. Include support and anchor details; reinforcement materials and grades and details of fabricating, bending, and placing reinforcement; number and location of splices; special reinforcement required for openings through shotcrete structures; formwork materials and details of formwork fabrication, assembly, and support; and locations of proposed construction joints.
- E. Samples: For each exposed product and for each color and finish specified. See Division 03 Section "Exhibit Rockwork".

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Material Certificates: For each of the following:
 - 1. Cementitious materials.
 - 2. Admixtures.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer employing nozzle operators for the Project, each of whom is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical and Overhead Positions as appropriate to the required shotcrete work. See Division 03 Section "Exhibit Rockwork."
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. ACI Publications: Comply with ACI 506.2, "Specification for Shotcrete," unless modified by requirements in the Contract Documents.
- D. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.
- E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for each finish required and for each design mixture, shooting orientation, and nozzle operator.
 - 2. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 3. Demonstrate curing and protecting of shotcrete, finishes, and joints, as applicable.
 - 4. In presence of Architect, damage part of the exposed-face surface for each color and finish, and demonstrate materials and techniques proposed for repair of holes and surface blemishes to match adjacent undamaged surfaces.
 - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Welded Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire, furnished in flat sheet.
- C. Mesh Screening (wire cloth): Galvanized, unpainted, 2" x 2" x 14 gauge. Square mesh, plain weave.
- D. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice."
- E. Metal Lath: ASTM-F 1267 galvanized, unpainted.

1. Type 1 – Expanded – 1/2”.
2. Class 2 – Grade ‘A’ coating designation (.00025 in mm coating).

2.2 SHOTCRETE MATERIALS

- A. Source Limitations for Shotcrete: Obtain each color, size, type, and variety of shotcrete material and shotcrete mixture from single manufacturer with resources to provide shotcrete of consistent quality in appearance and physical properties.
- B. Portland Cement: ASTM C 150, Type I or Type III. Use only one brand and type of cement for Project.
- C. Normal-Weight Aggregates: ASTM C 33, from a single source.
- D. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored, water-reducing admixtures, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
- E. Water: Potable, complying with ASTM C 94/C, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
- F. Refer to Division 03 Section “Exhibit Rockwork” for more information and waterproofing.

2.3 ADMIXTURES

- A. General: ASTM C 1141, Class A (liquid) or Class B (non-liquid) but limited to the following admixture materials. Provide admixtures for shotcrete that contain no more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
 1. Coloring Admixture: Coloring agent as limited in "Shotcrete Materials" Article.
- B. Refer to Division 07 Section “Crystalline Waterproofing” for admixture.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry, or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.5 SHOTCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of shotcrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 506.2.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based laboratory trial mixture or field test data, or both.
- B. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.

- C. Admixtures: When included in shotcrete design mixtures, use admixtures according to manufacturer's written instructions.
- D. Design-Mixture Adjustments: Subject to compliance with requirements, shotcrete design-mixture adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.6 SHOTCRETE MIXTURES

- A. Shotcrete Mixture: Proportion mixture to provide shotcrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight wet-mix shotcrete having air content before pumping of 7 percent with a tolerance of plus or minus 1-1/2 percent.
 - 3. Color: As selected by Architect to match reference images.

2.7 SHOTCRETE EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
- B. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

2.8 BATCHING AND MIXING

- A. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C and furnish batch ticket information.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Concrete or Masonry: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces to saturated, surface-dry condition before shotcreting.
 - 1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
- B. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces to saturated, surface-dry condition before shotcreting.

3.2 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.

- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports, bolsters, chairs, spacers, and other devices as required to maintain minimum concrete cover.
- D. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
- E. Install welded wire reinforcement in longest practical 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.
- F. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

3.3 JOINTS

- A. General: Construct joints at locations indicated or as approved by Architect.
- B. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints unless otherwise indicated.
- C. Contraction Joints: Construct contraction joints in shotcrete using saw cuts 1/8 inch wide by 1/3 slab depth or joint-filler strips 1/4 inch wide by 1/3 shotcrete depth unless otherwise indicated.
 - 1. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
 - 2. Space joints horizontally and vertically.
 - 3. Tool edges round on each side of strip inserts if floated or troweled finishes are required.
 - 4. Where shooting over an existing substrate joint, align new shotcrete joint with existing joint.

3.4 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. See Division 03 Section "Exhibit Rockwork".

3.5 APPLICATION

- A. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
- B. Apply shotcrete according to ACI 506.2.
- C. Apply wet-mix shotcrete materials within 90 minutes after batching.
- D. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.

1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
 - E. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.
 - F. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
 - G. Do not permit shotcrete to sag, slough, or dislodge.
 - H. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
 - I. Do not disturb shotcrete surfaces before beginning finishing operations.
 - J. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
 - K. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117, increased by a factor of two.
 - L. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1 and as follows. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 1. Discontinue shotcreting when ambient temperature is 40 deg F and falling.
 2. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F and not more than 90 deg F.
 3. Do not use frozen materials or materials containing ice or snow.
 4. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
 - M. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to recommendations of ACI 305.1 when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
 1. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 90 deg F for wet mix.
 2. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F before shotcreting.
 - N. Note that time of shotcrete placement is entirely dependent upon the Contractor and in accordance with his Project Completion Schedule. If shotcrete is to be placed during cold- or hot-weather conditions as defined by ACI, there will be no additional cost to the Owner.
- 3.6 SURFACE FINISHES
- A. General: Finish shotcrete according to descriptions in ACI 506R.
 - B. Finish-Coat Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, 1/4 to 1 inch thick, using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 sieve to provide a finish of uniform texture and appearance.
 - C. Finish-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, 1/4 to 1 inch thick, using ACI 506R, Grading

No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 sieve, and apply finish.

3.7 CURING

- A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
- B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.
- C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray 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. Apply curing compound to natural gun finish or flash-coat shotcrete at rate of 1 gal./100 sq. ft..

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
- B. Air Content: ASTM C 173/C, volumetric method or ASTM C 231, pressure method; one test for each compressive-strength test for each mixture of air-entrained, wet-mix shotcrete measured before pumping.
- C. Shotcrete Temperature: ASTM C 1064/C; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive-strength specimens.
- D. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mixture and for each workday or for every 50 cu. yd. of shotcrete placed, whichever is less. Produce test panels with dimensions of 24 by 24 inches minimum and of average thickness of shotcrete, but not less than 4-1/2 inches. Testing agency will obtain sets of test specimens from each test panel.
 - 1. Compressive Strength Testing: One set of three unreinforced specimens. Test each set of unreinforced specimens for compressive strength according to ASTM C 1140 and construction testing requirements in ACI 506.2.
 - 2. Visual Core Grading: One set of three reinforced specimens. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.
- E. In-Place Shotcrete Testing: One set of three unreinforced cores for each mixture and for each workday or for every 50 cu. yd. of shotcrete placed, whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
- F. Strength of shotcrete will be considered satisfactory according to the following:
 - 1. Specimen Cores: Mean compressive strength of each set of three unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.

2. Specimen Cubes: Mean compressive strength of each set of three unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

3.9 REPAIRS

- A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
 1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs.
 2. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders.
 3. Dampen surfaces and apply new shotcrete. Match adjacent color and finish.
- B. Repair core holes from in-place testing according to repair provisions in ACI 301, except do not use shotcrete. Match adjacent color and finish.

3.10 CLEANING

- A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 033713

SECTION 044300 – STONE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the furnishing of all labor, materials, setting materials, accessories, and equipment for the proper installation of the following items as indicated on the Contract Documents:
 - 1. Flagstone seat wall coping
 - 2. Natural stone seat wall facing

- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 31 Section "Earth Moving" for excavation, filling, and rough grading.
 - 2. Division 3 Section "Cast-In-Place Concrete" for concrete footings.
 - 3. Division 4 Section "Adhered Stone Masonry Veneer" for masonry wall construction.
 - 4. Division 7 Section "Joint Sealants" for sealing joints with elastomeric sealants in expansion joints of stonework

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

- B. Product Data: submit manufacturers technical data for each manufactured product in the categories listed below, including certification that each product complies with specified requirements. Indicate that Installer has received copy of manufacturer's instructions.
 - 1. Each stone type.
 - 2. Setting, pointing, and grouting materials
 - 3. Anchors, cables, and ties
 - 4. Cleaning products.

- C. Maintenance data to include in the Maintenance Manual specified in Division 1 Section "Project Closeout."

- D. Samples: submit samples for each color, grade, finish, type, and variety of stone consisting of:
 - 1. 12-inch-square units for veneers, facing, coping, and balustrades.
 - 2. For natural stone constructions, provide samples that are minimum 8-inch-square and are representative in sizes and shapes to be used in each construction.

 - 3. Include a minimum of three units in each set showing the full range of visual characteristics to be expected in the completed Work. Sample submittals will be reviewed for visual characteristics only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

- E. Shop drawings indicating cut sizes, dimensions, sections, and profiles of cut and turned stone units, and arrangement and provisions for jointing, supporting, anchoring, and attaching these units. Show details of connection, jointing, and reception of related work.

1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in supplying products similar to those indicated for the work in this Section with a record of successful in-service performance.
- B. Installer Qualifications: Engage an Installer who has not less than 5 years experience and who has completed works that are similar in the material, design, and extent indicated for this Section and who has performed those works successfully.
- C. Single-Source Responsibility for Stone: Obtain each color, grade, finish, type, and variety of stone from a single source with resources to provide materials of consistent quality in appearance and physical properties, including capacity to cut and finish material without delaying the progress of the stone installation.
- D. Quarry visits: the Architect shall visit each quarry or stone supplier where the natural stone for this Section will originate, prior to shipment of material. Natural stone shall be transported only after approval by the Architect. Architect reserves the right to select natural stone based on specific visual characteristics.
- E. Single-Source Responsibility for Setting Materials: Obtain mortar, grout, and dry-mix ingredients of uniform quality, and from one manufacturer for each cementitious and admixture component, and from one source or producer for each aggregate.
- F. Field-Constructed Mockup: Build mockups, of full thickness, to comply with the following requirements:
 - 1. Locate mockups on site to show the following:
 - a. Seat wall coping construction of a size that clearly shows joints and any special features for expansion joints and adjacent work.
 - c. Natural stone walls (each type), of sizes that clearly show typical arrangements of stones and any special features for expansion joints and adjacent work.
 - 2. In each mockup, provide range of color, texture, and workmanship to be expected in the completed work.
 - 3. Mockups may be on site at the location of actual work and incorporated into the work if approved. Reworking of the mockups at an on site condition shall not violate the originally designed grades or intended finished product.
 - 4. Notify Architect 1 week in advance of each mockup construction.
 - 5. Obtain Architect's acceptance of mockup before proceeding with installation.
 - 6. Retain mockups, if not a part of final installation, during construction as a standard for judging installed exhibit paving and curbs. Do not alter, move, or destroy mockup until date of Final Acceptance.
 - a. When directed by Architect, demolish and remove mockup from Project site.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with fabricator's instructions and recommendations for delivery, storage, and handling requirements.
- B. Delivery: Deliver materials to Project site in an undamaged condition.
- C. Storage: Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage, chipping, or cracking.

1. Store stones on protected wood skids or pallets, covered with nonstaining, water-protective membrane. Place skids and stack stones to distribute weight evenly and to prevent stones from breaking or cracking.
 2. Allow air to circulate around stones.
 3. Store cementitious materials off ground, under cover, and in a dry location.
 4. Store aggregate materials covered and in a dry location.
- D. Handling: Handle stone to prevent chipping, breakage, soiling, or other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials. Lift with wide-belt type slings wherever possible; do not use wire ropes or ropes containing tar or other substances which might cause staining. If required, use wood rollers and provide cushion at end of wood slides.

1.5 PROJECT CONDITIONS

- A. General: Protect stonework during erection as follows.
1. Prevent staining of stone from other sources. Immediately remove such materials without damage to stonework.
- B. Cold Weather Protection:
1. Do not set stone when air temperature or material temperature is below 50 deg F (10 deg C).
 2. Maintain minimum ambient temperatures of 50 deg F (10 deg C) during installation and for 7 days after completion, unless higher temperatures are required by fabricator or supplier instructions.
- C. Hot Weather Protection:
1. Protect masonry in hot weather to prevent excessive evaporation of cooling beds. provide artificial shade, wind breaks, and use cooled materials as required.

1.6 COORDINATION

- A. The specialty nature of this project requires coordination of all trades necessary to complete the work. Construction of exhibit systems such as, but not limited to, landscape, structure, mechanical, and plumbing must be coordinated with the construction of exhibit fabrications and systems included in this Section.
- B. Establish regularly scheduled coordination meetings with the Stonework Contractor and all other Contractors with work adjoining or in exhibit areas.
1. Contractor shall be responsible for taking meeting notes at coordination meetings.
 2. Provide a copy of meeting minutes to the Architect, within 3 days of each meeting.
 3. Prepare coordination drawings to resolve conflicts before installation occurs.
 4. Notify Architect of conflicts and intended resolution.

1.7 SEQUENCING AND SCHEDULING

- A. Sequence stonework and rockwork installation with adjoining and related work to avoid damage and soiling during construction.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Comply with referenced standards and product requirements indicated and applicable to each stone type required.
- B. Provide matched blocks from a single quarry for type, variety, color and quality of stone, where consistency in visual qualities is required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to the Architect.
- C. Fabricator to supervise quarrying of stone, where consistency in visual qualities is required. to ensure that as quarried block orientations yield finished stone with required characteristics.
- D. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by applicable stone association.
- E. Provide stone that is free of cracks, seams, and starts impairing structural integrity or function.

2.2 NATURAL STONE

- A. Type: Weathered Fieldstone. – match stonework historic Bear structure.
- B. Color Range: Light to dark browns and grays. Color streaking and variations due to mineral content shall be acceptable.
- C. Sizes: As indicated on the Drawings.

2.3 FLAGSTONE

- A. Type: Pennsylvania Bluestone.
- B. Color: Grey and Blue-Gray
- C. Finish: As follows:
 - 1. Capstone: Thermal face (top and front); sawn edges
- D. As indicated on the Drawings.

2.4 MORTAR AND GROUT MATERIALS

- A. Mortar shall be mixed in proportions by volume of one (1) part Portland Cement and three (3) parts Sand, measured in damp loose condition. For the mortar joints, color shall be added through pigments as required to obtain a color match for each type of curbing.
- B. Portland Cement: ASTM C-150, Type I low-alkali, nonstaining cement. Provide gray or white cement as needed to produce mortar color as required.
- C. Hydrated Lime: ASTM C-207, Type S
- D. Aggregate: ASTM C-144, clean masonry sand, as indicated below:
 - 1. For joints narrower than 1/4 inch, use aggregate graded with 100 percent passing a No. 8 sieve, and 95 percent passing a No. 16 sieve.
 - 2. For pointing mortar, use aggregate graded with 100 percent passing a No. 16 sieve.
 - 3. White Aggregates: Natural washed white sand or ground white stone.
- E. Water: Clean, non-alkaline, and potable.
- F. Pigments: Commercial iron-oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, suitably compounded for use in mortar mixes.

2.5 EXPANSION JOINT MATERIAL

- A. Construct expansion joints in stone work as per the requirements for each application specified in Division 7 Section "Joint Sealants".

2.6 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturer's instructions related to mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality and with optimum performance characteristics.
 - 1. Do not add admixtures including air-entraining agents, accelerators, retarders, water-repellent agents, anti-freeze compounds, or calcium chloride, unless specifically approved in writing by the Architect.
 - 2. Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with referenced ASTM or ANSI standard, as applicable, for mixing time and water content.
 - 3. Use only enough water to produce a stiff mix that produces a moist surface at the time curb units are set.
- B. Setting Mortar: Comply with ASTM C-270, Proportion Specification, for types of mortars and applications required below.
 - 1. Set natural stone units Type M mortar.
 - 2. Set bluestone units with Type N mortar.
- C. Pointing Mortar: Provide pointing mortar complying with requirements indicated above for setting mortar, including type and one of the following:
 - 1. Colored Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Use the minimum amount of pigment possible to achieve the

required color. Do not exceed pigment-to-cement ratio of 1:10 by weight.

2.7 ANCHORS AND ATTACHMENTS

- A. Provide anchors and attachments of type and size required to support stone facing and veneers and fabricated from materials as indicated below:
 - 1. Stainless Steel: ASTM A 666, AISI Type 304, for anchors in direct contact with stone.
- B. Wire Tieback: No. 9 nonferrous of copper, bronze, or brass alloy.
- C. Copings: For cut stone copings provide Type 304 ASTM A-167 stainless steel anchors and dowels.

2.8 CUT-STONE, ACCESSORIES

- A. Setting Buttons: Resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone facing.
- B. Cleaner: Provide stone cleaners specifically formulated for stone types, finishes, and applications indicated as recommended by stone producer. Do not use cleaning agents containing acid or cleaning compounds and solutions containing caustic or harsh fillers, except where expressed by written approval from stone producer for stone type condition.

2.9 CUT-STONE, FABRICATION

- A. General: Fabricate cut stone facing as required to comply with requirements indicated, including details on Drawings and final shop drawings.
- B. Exposed surfaces and edges of cut and turned stone units shall be free from cracks, broken corners, chipped edges, scratches or other defects affecting appearance. Patching or filling not permitted.
- C. Cut and drill sinkages and holes in stones for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone facing securely in place. Shape beds to fit supports.
- D. Cut stones to produce units of thickness, size, and shape indicated on Drawings and noted in Schedules and within fabrication tolerances recommended by applicable stone association or stone source, for faces, edges, beds, and backs.
- E. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone and to match approved samples and field-constructed mockup.
- F. Sawn surfaces and edges shall be cleaned of all rust stains and particles.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the areas and conditions under which stonework is to be installed and surfaces to receive stone facing. Review with the Installer present for compliance with requirements for tolerances and conditions affecting installation performance. Report to the Architect in writing conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION, CLEANING

- A. Preparation: Advise Installers of adjoining and related work about specific requirements for placement of inserts, reglets, and similar items that will be used by stone facing Installer for anchoring, supporting, and setting stone units. Furnish Installers of related work with drawings or templates showing locations of these items.
- B. Cleaning, Stone: Clean stone surfaces prior to setting to remove soil, stains, and foreign materials. Clean stone units by thoroughly scrubbing stones with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh fillers or abrasives.
- C. Cleaning, Tufa Rock: Clean stone surfaces prior to setting to remove soil, mortar, and other foreign materials. Chip off old mortar with tools designed for the purpose, taking care to minimize wastage. Discard Tufa pieces whose structural integrity is impaired by the mortar removal process. Clean Tufa Rock units by thoroughly brushing stones with fiber brushes followed by a thorough drenching with clear water.

3.3 PROTECTION

- A. Take adequate precautions to protect all adjacent building elements, and new exhibit work, from damage during work of this Section.
- B. Any damage to building elements and exhibit work as a result of work included in this Section shall be repaired, by the necessary trades, to the satisfaction of and at no additional cost to the Architect.

3.4 INSTALLATION, GENERAL

- A. Fabricate and install stonework to withstand normal loads from gravity, movement, and thermally induced movement, as well as to resist deterioration under normal use, including exposure to weather, without failure.
- B. Do not use cut stone units with chips, cracks, voids, discolorations, and other defects which might be visible or cause straining in the finished work. Color variations intrinsic to Block Pumice shall be acceptable. Color variations in Tufa Rock due to previous use shall be acceptable.
- C. Quality Assurance: Execute stone facing by skilled workmen, trained and experienced in this kind of work, at Project site to set stone and complete field cutting, if required, as stones are set.
- D. Lines and Grades: Benchmarks for elevations and building line offset marks for alignment shall

be established on each floor level by the contractor, who shall be responsible for their accuracy. Should any error be found in their location, the Stone Subcontractor shall so notify the Contractor in writing and installation work shall not proceed in the affected areas until the errors have been corrected.

- E. Erection Tolerances: Permissible dimensional tolerance in the building frame and/or work surrounding the work of this Section are stated in the appropriate Trade Sections of these Specifications.

3.5 CUT-STONE, INSTALLATION

- A. Construction Tolerances: Set stones to comply with the following tolerances:

1. Variation of Elements from Level: Do not exceed plus or minus 1/4 inch in 10 feet, nor 1/2 inch maximum.
2. Variation of Elements from Plumb: For lines and surfaces of columns and walls, do not exceed plus or minus 1/4 inch in 10 feet, nor 3/8 inch in 20 feet, nor 1/2 inch maximum. At external corners, expansion joints, and prominent visual lines, do not exceed 1/4 inch in 10 feet, nor 1/2 inch maximum.
3. Variation of Elements True to a Line: For position shown in plan and related portion of columns and walls, do not exceed plus or minus 1/4 inch in 10 feet, nor 3/8 inch in 20 feet, nor 1/2 inch maximum.
4. Variation of Elements Indicated in Elevation: Do not exceed plus or minus 1/4 inch nor 3/4 inch maximum.

- B. Workmanship: Erect cut stone facing, balustrades, and trim plumb and true with uniform joint widths in accurate alignment and relation to established lines and grades, and as shown on the approved shop and/or erection drawings. Use setting buttons to maintain joint width.

1. Use power saws to cut stones. Produce exposed edges that are cut straight and true.
2. Set stones to comply with requirements indicated on Drawings and final shop drawings. Install ties, anchors, supports, fasteners, and related attachments indicated and necessary to secure stone facing in place. Shim and adjust to set stones accurately with uniform joints of widths indicated and with stone edges and faces aligned according to established lines and construction tolerances.
3. Point and grout joints after setting. Use mortar type or grout and color indicated. Tool joints uniform and smooth with plastic tool.
4. The vertical face dimension of any stone installed at corners or at the vertical sides of openings shall be no more than 1 1/2 times the horizontal face dimension of the stone.
5. Do not install stonework around openings until frames are in place. Take all steps necessary to protect finish on frames. Stones must have a uniform edge around openings as demonstrated in the mock-ups.

3.6 REPAIR AND CLEANING

- A. Defects: Remove stone units with the following defects:

1. Broken, chipped, stained, or otherwise damaged stones.
2. Defective joints.
3. Stones and joints not matching approved samples and field-constructed mockup.
4. Stone not complying with requirements indicated.

- B. Replacement: Replace damaged stone with new units to match approved samples and field-constructed mockups without evidence of replacement. Patching or hiding defects in stone will not be permitted.
- C. Cleaning: Clean stone installations after setting, pointing, grouting, and curing is complete. Use procedures recommended by stone producers for types of application. Repoint any open joints with mortar specified for the particular application.

3.7 PROTECTION

- A. Protect stone surfaces, edges, and corners from damage during subsequent construction activities, and from other materials that would cause stains.
- B. Provide protection for all finished stonework liable to physical injury or staining. Protection shall include, but is not limited to, non-staining approved coverings, and clean non-staining wood boxing. All fastenings or hold-back devices shall be galvanized steel. Fastening to stonework in any manner is prohibited.
- C. Before inspection for Final Acceptance, remove protective covering and clean surfaces using procedures, products, and materials recommended by stone producers.
- D. Examine all work and repair all damage. In the event damage is irreparable, or soiled or stained surface cannot be cleaned, then remove and replace such items.

END OF SECTION 04400

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SECTION 044313.16 - ADHERED STONE MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured stone masonry adhered to insulated sheathing over concrete backup.
2. Drainage mat used as a secondary layer of water-resistive/weather barrier.
3. Flexible flashing.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each variety of manufactured stone, accessory, and manufactured product.
2. Drainage mat.
3. Flexible flashing.

B. Samples for Verification:

1. For each manufactured stone type indicated. Include at least four Samples in each set, and show the full range of color and other visual characteristics in completed Work.
2. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.
3. Drainage mat.
4. Flexible flashing.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer with documented experience in installation of manufactured stone of type selected, approved or trained by manufacturer of stone, with

at least five successfully completed installations within sixty miles of the project site.

- B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.

1.7 FIELD CONDITIONS

- A. Protection of Manufactured Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides, and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter, using coverings spread on the ground and over the wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
- E. Note that time of manufactured stone installation is entirely dependent upon the Contractor and in accordance with his Project Completion Schedule. If manufactured stone is to be installed during cold- or hot- weather conditions as defined above, there will be no additional cost to the Owner.

1.8 COORDINATION

- A. Advise installers of other work about specific requirements for placement of flashing and similar items to be built into stone masonry.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Manufactured Stone: Obtain each variety of manufactured stone from single source with resources to provide materials of consistent quality in appearance and physical properties.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

2.2 MANUFACTURED STONE

- A. Material Standards:
 - 1. Compressive Strength: Not less than 1800 psi average for 5 specimens and not less than 2100 psi for individual specimen when tested in accordance with ASTM C 39 & ASTM C 192.
 - 2. Bond Between Manufactured Masonry Unit, Mortar and Backing: Not less than 50 psi when tested in accordance with ASTM C 482 using Type S mortar.
 - 3. Thermal Resistance: R-value of not less than 0.355 per inch of thickness when tested in accordance with ASTM C 177.
 - 4. Freeze/Thaw: No disintegration and less than 3 percent weight loss when tested in accordance with ASTM C 67.
 - 5. Water Absorption: Tested in accordance with UBC 15-5 9-22% depending on density value.
 - 6. Unit Weight: Not more than 15 psf saturated.
 - 7. UV Stable - Mineral oxide pigments.
- B. Basis of Design: Subject to compliance with Div 01 requirements regarding substitutions, provide Echo Ridge Southern LedgeStone as manufactured by Cultured Stone.

2.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix produces color indicated. Pigments do not exceed 10 percent of portland cement by weight.

1. 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:
 - a. Heidelberg Materials
 - b. Holcim (US) Inc
 - c. Lafarge North America Inc.
 - d. Laticrete International, Inc.
 2. Color: Match Mapei #5014-Biscuit. Successful match determined solely by the Architect.
- D. Aggregate: ASTM C144 and as follows:
1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
 2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
- E. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
1. 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:
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation
- F. Water: Potable.

2.4 EMBEDDED FLASHING MATERIALS

- A. Flexible Metal Flashing:
1. Basis of Design: Subject to compliance with Div 01 requirements regarding substitutions provide Flash-Vent SS as manufactured by York Manufacturing, Inc.. A comparable product by one of the following may be considered:
 - a. STS Coatings, Inc – Wall Guardian Venting Stainless Steel TWF.
 - b. Building Materials West Company, Inc – Evacu-Flash SS.
 2. Characteristics:
 - a. Type: Engineered system, with high resistant to damage, composite with a stainless steel with non-asphalt adhesive polymer fabric laminated to one stainless steel and non-woven drainage fabric laminated to opposing face with non-asphalt adhesive.
 - b. Stainless steel: type 304, ASTM A240. Domestically sourced per DFARS 252.225-7008 and/or DFARS 252.225-7009.

- c. Fabrics:
 - 1) Polymer fabric; laminated back face to stainless steel core
 - 2) Non-woven drainage fabric: Fabric laminated to front face stainless steel core.
- d. Size: Manufacturer's standard width rolls.

3. Accessories:

- a. Mastic/sealant: Product standard of quality is York Manufacturing, Inc.; UniverSeal US100.
 - 1) Characteristics:
 - a) Type: One part 100% solids, solvent-free formulated silyl-terminated polyether (STPE), ASTM C920-11, Type S, Grade NS, Class 50.
 - b. Outside corner and inside corner material; manufacturer's standard available units using preformed stainless steel: 26-gauge stainless steel.
 - c. End dam: Product may be folded in line with the flashing material or utilize preformed end dams by manufacturer using preformed stainless steel: 26-gauge stainless steel
 - d. Splice material: Product standard of quality is York304 SA by York. Manufacturer's standard self-adhered metal material.
 - e. Termination bar: Product standard of quality is York T-96 termination bar. Manufacturer's standard 1" composite material bar or a 1" 26-gauge stainless steel termination bar with sealant lip.
 - f. Drip Edge: Stainless-steel with 30-degree 3/8" bent outer edge, hemmed. 3" by 8'

2.5 DRAINAGE MAT

- A. Drainage Mat: Free-draining polymer-strand mesh sheets or strips with thickness not less than 1/4 inch and installed to full height of wall, to maintain a continuous open space behind exterior cladding.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mortair Vent 202 - Advanced Building Products Inc.
 - b. Rainscreen Mat WS - CavClear; a division of Archovations, Inc.
 - c. Rainscreen Drainage and Ventilation Mat - Huber Engineered Woods LLC.
 - d. LathNet - Mortar Net Solutions
- B. Location: Behind portland cement plaster and adhered manufactured stone veneer.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

- A. Weep Products: Use the following:

1. Mesh Weep Holes: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches high by thickness of stone masonry; in color selected from manufacturer's standard.
- B. Expanded Metal Lath: 3.4 lb/sq. yd., self-furring, diamond-mesh lath complying with ASTM C847. Fabricate from structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G60.
- C. Lath Attachment Devices: Material and type required by ASTM C1063 for installations indicated.

2.7 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.
 1. 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:
 - a. Diedrich Technologies, Inc.; a Hohmann & Barnard company
 - b. Laticrete International, Inc.
 - c. PROSOCO, Inc

2.8 FABRICATION

- A. General: Fabricate manufactured stone units in sizes and shapes required to comply with requirements indicated.
- B. Select manufactured stone units to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.
- C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.
- D. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples[**and mockups**].

2.9 MORTAR 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.
 2. Use portland cement-lime mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is

- consistent.
4. **Mixing Pointing Mortar:** Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. **Preblended, Dry Mortar Mix:** Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
 - C. **Latex-Modified Portland Cement Setting Mortar:** Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.
 - D. **Cement-Paste Bond Coat:** Mix either neat cement and water or cement, sand, and water to a consistency similar to that of thick cream.
 1. For latex-modified portland cement, setting-bed mortar, substitute latex admixture for part or all of water, according to latex-additive manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive manufactured stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING MANUFACTURED STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.
 1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
 2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make

edges straight and true, matching similar surfaces that were shop or quarry fabricated.

3. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.
- D. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.
- E. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- F. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
- G. Maintain uniform joint widths, except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 1/4 inch at narrowest points or more than 1/2 inch at widest points.
- H. Provide sealant joints of widths and at locations indicated.
 1. Keep sealant joints free of mortar and other rigid materials.
 2. Sealing joints are specified in Section 079200 "Joint Sealants."
- I. Install embedded flexible flashing and weep holes at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated on Drawings.
 1. Extend flashing through stone masonry, up sheathing face at least 8 inches, and behind drainage mat.
 2. At lintels, extend flashing full length of opening but not less than 6 inches into masonry at each end.
 3. At sills, extend flashing not less than 4 inches at ends.
 4. At ends of head and sill flashing, turn up not less than 2 inches to form end dams.
 5. Install metal drip edges beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch back from exterior wall face, and adhere flexible flashing to top of metal drip edge.
- J. Place weep holes at flashing.
 1. Use open head joints to form weep holes.
 2. Space weep holes 24 inches o.c.
 - 3.

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet,

3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
- C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.
- D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.
- E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ADHERED STONE MASONRY VENEER

- A. Install flashing over sheathing and drainage mat by fastening through sheathing into framing.
- B. Install lath over drainage mat by fastening through sheathing to comply with ASTM C1063.
- C. Install scratch coat over metal lath 3/8 inch thick to comply with ASTM C926.
- D. Coat backs of stone units and face of scratch coat with cement-paste bond coat, then butter both surfaces with setting mortar. Use sufficient setting mortar, so a slight excess will be forced out the edges of stone units as they are set. Tap units into place, completely filling space between units and scratch coat.
- E. Rake out joints for pointing with mortar to depth of not less than 3/4 inch before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

- A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch deep until a uniform depth is formed.
- B. Point stone joints by placing and compacting pointing mortar in layers of not more than 3/8 inch deep. Compact each layer thoroughly, and allow to it become thumbprint hard before applying next layer.
- C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:

1. Joint Profile: Smooth, flat face slightly below edges of stone.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
 2. Defective joints.
 3. Stone masonry not matching approved samples.
 4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
 5. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.

3.8 EXCESS MATERIALS AND WASTE

- A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.
- B. Excess Masonry Waste: Remove excess clean masonry waste, and other waste, and legally dispose of off Owner's property.

END OF SECTION 044313.16

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other steel items not defined as structural steel.
2. Section 099600 "High-Performance Coatings" for painting requirements.

1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 COORDINATION

- A. 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.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Anchor rods.
4. Threaded rods.
5. Shrinkage-resistant grout.

- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, holes, and other pertinent data.
 - 2. Include embedment Drawings.
 - 3. 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.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
 - 5. Identify members not to be shop primed.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint, including the following:
 - 1. Power source (constant current or constant voltage).
 - 2. Electrode manufacturer and trade name, for demand-critical welds.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator.
- B. Welding certificates.
- C. Mill test reports for structural-steel materials, including chemical and physical properties.
- D. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
- E. Field quality-control reports.

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 BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

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.
- 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 F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 360.
 - 2. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 - 1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2.2 STRUCTURAL-STEEL MATERIALS

- A. Angles: ASTM A36/A36M.
- B. Plate and Bar: ASTM A36/A36M unless noted otherwise on drawings.
- C. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.
- D. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
- E. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325N, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain

finish.

2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 36.
 - 1. Configuration: JHooked unless noted otherwise on structural drawings.
 - 2. Nuts: ASTM A563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A36/A36M carbon steel.
 - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- B. Headed Anchor Rods: ASTM F1554, Grade 36, unless noted otherwise on structural drawings,, straight.
 - 1. Nuts: ASTM A563 heavy-hex carbon steel.
 - 2. Plate Washers: ASTM A36/A36M carbon steel.
 - 3. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 4. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 SHRINKAGE-RESISTANT GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 - 1. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 - 2. Mark and match-mark materials for field assembly.
 - 3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- 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, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

- A. 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.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform quality control shop tests and inspections.
 - 1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 - 2. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 - 3. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- 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 on Drawings.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates, Bearing Plates, 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.
 - 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. Promptly pack shrinkage-resistant 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 grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- 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 are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.

- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 REPAIR

- A. Touchup Painting:
 - 1. Cleaning and touchup painting are specified in Section 099600 "High-Performance Coatings."

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.

END OF SECTION 051200

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.

1.2 COORDINATION

- A. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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:

1. Fasteners.
2. Shrinkage-resisting grout.

- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

- A. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- B. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers unless noted otherwise. See structural drawings for mast anchor bolt grade and type requirements.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- C. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- D. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.4 MISCELLANEOUS MATERIALS

- A. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop..
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously 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.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- G. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from 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.
- C. Galvanize miscellaneous framing and supports.

2.7 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. 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.
- B. 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. 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.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF 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.
- B. Support steel tube columns on solid grouted concrete. Secure columns with anchor bolts embedded in concrete or with anchor bolts or post-installed bolts through bearing plates.

3.3 REPAIRS

A. Touchup Painting:

1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop galvanizing are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 055000

SECTION 055119 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Metal grating stairs.
 2. Steel railings and guards.

1.2 ACTION SUBMITTALS

- A. Product Data: For metal grating stairs and the following:
1. Gratings.
 2. Welded-wire mesh.
 3. Grout.
- B. Shop Drawings:
1. Include plans, elevations, sections, details, and attachment to other work.
 2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
 3. Include plan at each level.
- C. Delegated Design Submittal: For stairs, railings, and guards, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- B. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
 - 1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
 - 2. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, railings, and guards, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft..
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to L/360.
- C. Structural Performance of Railings and Guards: Railings and guards, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
 - 3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam

marks, roller marks, rolled trade names, or blemishes.

- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- D. Steel Wire Rod for Grating Crossbars: ASTM A510/A510M.
- E. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed), or, ASTM A513/A513M.
 - 1. Provide galvanized finish for exterior installations.
- F. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
- G. Provide galvanized finish for exterior installations.
- H. Welded-Wire Mesh: Diamond pattern, 2-inch welded-wire mesh, made from 0.236-inch nominal-diameter steel wire complying with ASTM A510/A510M.

2.3 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.
 - 1. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs.
- D. Post-Installed Anchors: Torque-controlled expansion anchor or, chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20

and compatible with paints specified to be used over it.

- C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for exterior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections 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 to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish # 3 - Partially dressed weld with spatter removed.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that are exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Fabricate stringers of steel plates or channels.
 - a. Stringer Size: As required to comply with "Performance Requirements" Article.
 - b. Provide closures for exposed ends of channel stringers.
 - c. Finish: Galvanized.
 - 2. Construct platforms and tread supports of steel plate or channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel framing.
 - b. Finish: Galvanized.
 - 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
 - 1. Fabricate treads and platforms from welded steel grating with openings in gratings no more than 1/2 inch in least dimension.
 - a. Surface: Serrated.
 - b. Finish: Galvanized.
- D. Risers: Open.
- E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms.
 - 1. Material and Finish: Steel plate to match finish of other steel items.
 - 2. Fabricate to dimensions and details indicated.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.
 - 1. Rails and Posts: 1-5/8-inch- diameter top and bottom rails and 1-1/2-inch- square posts.
 - 2. Mesh Infill: Welded-wire mesh welded into 1-by-1/2-by-1/8-inch steel channel frames. Orient wire mesh with diamonds vertical.

- B. Welded Connections: Fabricate railings and guards with welded connections.
 - 1. Fabricate connections that are exposed to weather in a manner that excludes water.
 - a. Provide weep holes where water may accumulate internally.
 - 2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
 - 3. Weld all around at connections, including at fittings.
 - 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 5. Obtain fusion without undercut or overlap.
 - 6. Remove flux immediately.
 - 7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #3 - Partially dressed weld with spatter removed as shown in NAAMM AMP 521.
- C. Form changes in direction of railings and guards as follows:
 - 1. By bending.
- D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.
 - 1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of railing and guard members with prefabricated end fittings.
- F. Connect posts to stair framing by direct welding unless otherwise indicated.

2.8 FINISHES

- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
 - 1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 - 2. Comply with requirements for welding in "Fabrication, General" Article.

3.3 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
 - 1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 - 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
 - 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to steel by welding to steel supporting members.

3.4 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055119

SECTION 055964 - GALVANIZED STEEL ANIMAL CAGING & KEEPER GATES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Fabrication and installation of all animal caging and keeper gates. All work of this Specification Section shall be fabricated of Galvanized Steel, unless specifically noted otherwise. Items fabricated and installed under this Section includes, but is not necessarily limited to:
1. Wire Mesh Caging Panels.
 2. Shop Fabricated Galvanized and Welded Ferrous Metal Framing for Animal Caging.
 3. Keeper Access Gates.
 4. Requirements for constructing full-scale operable mock-ups.
 5. Benches
 6. Feeders
 7. Misc. Shop Fabricated Galvanized Ferrous Metal Items Required for a Complete and Proper Installation.
 8. Finish Hardware and Schedule.
 9. Animal Management Requirements of Construction.

1.2 RELATED DOCUMENTS

- A. Division 05 "Metal Fabrications."

1.3 PRE-QUALIFIED METAL FABRICATORS AND INSTALLERS

- A. Only Subcontractors whose experience and workmanship that have been previously reviewed and pre-qualified by the Architect/Exhibit Designer for the Work of this Section. Qualifications for companies include a minimum of five (5) years of experience in metal work of this type, plus a minimum of three (3) similar projects involving containment of animals. Companies requesting consideration shall submit written and photographic proof of previously performed projects.
- B. Subject to the compliance with the requirements of these Specifications, pre-qualified fabricators and installers for galvanized steel gaging fabrication and installation include but are not limited to the following:

1. A thru Z Consulting and Distributing, Inc.
8620 E. Old Vail Road, Suite 100
Tucson, AZ 85747
Phone: (520) 434-8281
2. Corners Limited
841 Gibson Street
Kalamazoo, MI 49001

Phone: 1(800) 456-6780

1. Thermeq
1070 Disher Drive
Watervale, OH 43566
Phone: (419) 878-4400

1.4 REFERENCES

- A. ASTM A36 Structural Steel.
- B. ASTM A53 Hot Dipped, Zinc coated Welded and Seamless Steel Pipe.
- C. ASTM F3125 High Strength Bolts for Structural Steel Joints.
- D. ASTM A123 Zinc Coating (Hot Dip) on Assembled Steel Products.
- E. ASTM A500 Cold formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- F. ASTM A501 Hot formed Welded and Seamless Carbon Steel Structural Tubing.
- G. AWS D1.1 Structural Welding Code.
- H. NAAM Standard HMMA 863 - Guide Specifications for Detention/Security Hollow Metal Doors and Frames.
- I. ASTM A780 Repair of Damaged Hot-Dip Galvanized Coatings

1.5 FIELD MEASUREMENTS

- A. Prior to submission of shop drawings, the Caging Contractor shall verify that all field measurements are as indicated on Caging Drawings (CG) and Schedules and notify the Architect (BKP) in writing of any major discrepancies. No fabrication shall proceed until all inconsistencies are corrected.

1.6 SUBMITTALS

- A. Pre-detailing Conference: Contractor shall schedule and hold a prefabrication meeting at the site or by remote video conference (Zoom, Skype, WebEx, etc.) to coordinate specification and shop drawing issues prior to the first shop drawing submittal. Attendees shall include the contractor's project manager, the detailer, the fabricator, the erector, the structural engineer of record and the testing agency.
- B. Submit Shop Drawings, Product Data, Field Mock-up and Samples to the requirements relevant to Division 01 Section "Submittal Procedures".
- C. Shop Drawings:

1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 2. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.
- D. Product Data: Provide product data on padlocks, sprockets, ball-screw assemblies, finish paint systems, and other pertinent items.
- E. Samples: Submit one 24" x 24" sample of each mesh type and size specified, showing typical termination conditions, typical welded connections, and other pertinent construction components. See CG drawings.
- F. Full-Scale Mock-Up: Refer to 1.7 below for requirements.
- G. Production runs of all components shall be contingent on the results of the review process and acceptance of the working mock-up.

1.7 FULL-SCALE MOCK-UPS

- A. Prior to the construction of exterior building walls and exhibit spaces, and immediately upon receipt of the notice-to-proceed with construction work, the Contractor shall be required to construct "mock-up" panels at the project site using exposed construction materials, bonding, tooling and reinforcement to be utilized in the actual construction. Obtain Architect's written approval of the "mock-up" panel prior to starting actual construction work. Provide mock-up panels with applicable sized concrete and/or masonry footings as follows:
1. Panel for Keeper Gates: One (1) of each type, full scale mesh panel and gate assembly utilizing mesh, keeper gates, framing and operating hardware and mechanisms indicated in the construction documents. Panel shall demonstrate actual workmanship and operation expected in the completed work.
 2. Caging Panels: Cage Front: One (1) of each type, full-scale cage front utilizing components as indicated in the construction documents. Panel shall demonstrate actual workmanship and operation expected in completed work. Small animal holding and Medium/Large Animal holding.
- B. All mock-ups shall serve to demonstrate construction methods, operability (where required), finishes, etc.
- C. Coordinate field reviews of all mock-ups with representatives of Owner and Architect. Make all adjustments required by the Owner and/or Architect at no additional cost to the Project. If significant adjustments are required, schedule an additional review with the required parties.
- D. Obtain from the Owner and Architect written statements accepting mock-ups as the basis for construction of the respective assemblies and systems. Do not begin fabrication of any affected assemblies until written acceptance is obtained.
- E. Do not alter, move or destroy "mock-up" panels until approval is granted or as otherwise directed by the Architect. Damage or destruction of the panel prior to approval shall be cause for its replacement at the expense of the Contractor.

- F. Mock-ups may remain as part of the final work if accepted by the Owner and Architect. Mock-ups that are not to remain as part of the Final Work shall be dismantled and removed off-site.

PART 2 - PRODUCTS

2.1 MESH PANELS ASSEMBLIES

- A. Welded Wire Mesh Panel Assemblies: All mesh panel assemblies shall be fabricated from steel components, comprised of the materials indicated on the drawings. Mesh panels shall be installed where indicated, as animal caging, keeper gates, and elsewhere as indicated.
1. All Mesh Panel Assemblies shall be galvanized after fabrication, to a minimum of G-90 coating designation (ASTM A-653).
 - a. All Mesh Panel Assemblies shall be free from warp after galvanizing.
 - b. Sharp drips left on mesh after galvanizing
- B. Steel Sections: ASTM A36, galvanized.
- C. Steel Tubing: Galvanized steel in shapes and sizes indicated on the Drawings conforming with ASTM A501.
- D. Cords and Wires: Stainless Steel. For Guillotine Doors
- E. Fasteners, Bolts, Nuts, and Washers: ASTM A325; all bolts, machine screws and fasteners shall be either torx or hex socket round head and flat head as indicated on the drawings except where specifically noted otherwise.
- F. Welding Materials: AWS D1.1; type required for materials being welded.
- G. Touch up Primer for Galvanized Surfaces: ZRC or approved equal to match color of galvanized panels for all field welded surfaces. Cold galvanizing is intended for limited touch-up only and will be acceptable only for those areas necessary for field welds.
- H. Exposed Mechanical Fastenings: Flush countersunk torx or hex socket machine screws and bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- I. Anchor Bolts: Hilti countersunk flathead hex socket "kwik-Bolts" for installation in monolithic concrete and chemical expansion hit-anchors for concrete block walls in sizes indicated on the Drawings, unless specifically noted otherwise.
- J. Galvanized steel assemblies shall be free from burrs. Grind smooth all assemblies prior to galvanization.

2.2 GATE HARDWARE

- A. Refer to caging schedules and details on caging drawings.
- B. Substitutions: All substitutions for the hardware of this Section must be reviewed and approved by the Architect/Exhibit Designer and Owner prior to Bid acceptance.

C. Hinges:

1. Where hinges are specified for keeper gate and heavy-duty doors, they shall be greasable barrel hinges or box hinges sized for weight of door assembly.
2. Unless scheduled otherwise, furnish one pair of hinges for doors up 60" high. Furnish one additional hinge for every 30" additional fraction thereof. Exterior doors or gates shall be furnished with hinges of non-ferrous metal. Where hardware sets are marked "non ferrous" furnish non-ferrous metal hinges. All exterior doors, which open at reverse bevel, shall be furnished with NRP hinges.

D. Padlocks:

1. Padlocks will be provided by Owner.

E. Door Pulls

1. See drawings.

F. Slide Bolts & Staples:

1. See drawings.

G. Cane Bolts:

1. See drawings.

H. Spring Bolts:

1. See drawings.

I. Padlocks Tabs:

1. As indicated on Drawings.

J. Silencers:

1. All interior doors shall be furnished with rubber silencers. Furnish 3 for single doors and 2 for pairs of doors. Silencers can be put on gate and door stop plates.
2. Silencers shall be furnished loose by the steel frame supplier. Holes in frames 'stop-strip' shall be factory drilled for a snap-in silencer installation. Glued on or adhesive back silencers are unacceptable.

K. Finishes:

1. Unless otherwise noted, all hardware shall be furnished in accordance with the following list:
 - a. Pulls, push, kick plates US32D (630)
 - b. Lock trim, Exit devices US32D (630)
 - c. Hinges, Misc. (ferrous) US26D (652)
 - d. Hinges, Misc. (non-ferrous) US26D (626)

2.3 SEALANT

- A. Epoxy Sealant: Provide fabricator's recommended epoxy sealant at required locations and/or locations identified on Drawings.

2.4 FABRICATION

- A. Verify dimensions on site prior to shop fabrication.
- B. Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline.
- C. Continuously seal joined members by continuous welds.
- D. Fit and shop assemble in largest practical sections, for delivery to site.
- E. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.
- F. Exposed Mechanical Fastenings: Flush countersunk torx or hex socket machine screws and bolts; stainless steel finish; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- G. Anchor Bolts: Hilti countersunk flathead hex socket "Kwik-Bolts", stainless steel finish, for installation in monolithic concrete and chemical expansion hit-anchors for concrete block walls in sizes indicated on the Drawings, unless specifically noted otherwise

2.5 SHOP – APPLIED PROTECTIVE COATING:

- A. Shop-apply a thin layer of surface oil as a protective coating of all galvanized products prior to shipment to Project site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that field conditions are acceptable and are ready to receive work. Do not install until any unsatisfactory conditions are corrected. Beginning Work constitutes contractor's acceptance of conditions as satisfactory.
- B. Obtain Architect/Engineer approval prior to site cutting or making adjustments not scheduled.
- C. Clean and strip site primed steel items to bare metal where site welding is scheduled.
- D. Make provision for erection loads with temporary bracing. Keep work in alignment.
- E. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate trades.

3.2 COORDINATION

- A. Coordinate all material requirements with other pertinent specification Sections relevant to the Work of this Section.

3.3 PREPARATION OF STEEL ASSEMBLIES

- A. Verify dimensions on site prior to shop fabrication.
- B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- C. Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline. All oversized holes required for fabrication shall be welded & plugged. No holes, cavities, or other voids, will be acceptable, unless specifically designed into the caging system.
- D. Continuously seal joined members by continuous welds.
- E. Fit and shop assemble in largest practical sections, for delivery to site.
- F. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius of 1/8". Radius all corners to 1/4".
- G. Galvanized items to minimum 2.0 oz./sq. ft zinc coating in accordance with ASTM A123.
- H. Do not prime surfaces in direct contact bond with concrete or where field welding is required. Prime paint items scheduled with one coat.

3.4 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Perform field welding in accordance with ASW D1.1.
- C. After installation, touch-up field welds, scratched or damaged surfaces with specified touch-up primer.
- D. Remove all sharp edges, burrs, corners and slivers that, in the opinion of the Architect, and/or Owner could injure animals or keepers.
- E. Apply recommended sealant to all gaps in any of the following areas:
 - 1. Between adjacent construction.
 - 2. Where specifically detailed.
 - 3. Where required to comply with the Animal Management Requirements of Construction procedures listed elsewhere in this Specification Section

3.5 WELDING REQUIREMENTS

- A. All exposed welds shall be ground smooth and galvanized.
- B. Remove all sharp edges, burrs, corners, and slivers, which in the opinion of the Architect and/or Owner, could injure animals or keepers.

3.6 ANIMAL MANAGEMENT AND REQUIREMENTS OF CONSTRUCTION

GALVANIZED STEEL ANIMAL CAGING & KEEPER GATES

- A. The following work items shall be installed and/or performed as part of the Base Work of this Section, whether or not specifically detailed or noted on the Drawings:
1. Exposed threaded bolts/studs shall be cut back to a maximum 1/8" projection wherever they occur within animal spaces. Bolt threads to remain operational after cutting.
 2. All gaps larger than 1" clear between installed items and new construction, shall have a continuous section of 12ga galvanized steel plate welded to post to reduce gaps to 1" or less. This does not apply to any larger gaps specifically detailed (as indicated on the drawings) into the work of this section.
 3. Guard plates fabricated from 12ga galvanized steel shall be installed wherever exposed cables on the keeper side occur within 12" from the face of any gap in the construction. These guard plates shall be welded to the construction and extend minimum of 4" beyond the cables in any direction.
 4. Cover plates to be fabricated from 12ga galvanized steel and be installed wherever exposed cables, plumbing lines, and electrical lines occur within animal holding rooms, or within animal reach through and/or over caging. Cover plates to be field bolted 1/4" dia bolts at 24" o.c.
 5. In order to minimize vermin infestation, all gaps occurring in any adjoining construction shall be caulked and sealed tight with the specified epoxy sealant to the requirements of Division 07.

END OF SECTION 055964

SECTION 055968 - STAINLESS STEEL MESH STRUCTURES AND RIGGING SYSTEMS

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. Fabrication and installation of complete, functioning, and safe animal caging systems. All work of this Section shall be fabricated with materials noted on the plans and in the specifications. Work shall be coordinated with the building, building systems, site and site systems. Items fabricated and installed under this Section includes, but is not limited to:

1. Red Panda Project - Outdoor Mesh Enclosures. Habitats A and Habitat B
2. Miscellaneous shop and field fabricated items required for a complete and proper installation.

- B. Prototyping, design, engineering, fabrication and installation of complete, functioning, and safe animal caging systems. All work of this Section shall be fabricated with materials noted on the plans and in the specifications. Work shall be coordinated with the building, building systems, site and site systems. Items fabricated and installed under this Section includes, but is not limited to:

1. Animal enclosure structural support systems, rigging and woven wire rope mesh animal containment.
2. Contractor shall anticipate and provide the following sequence of work in order to establish each of the two above systems:
 - a. Review of Bid Documents to understand overall design intent, function and aesthetic.
 - b. Pre-detailing conference: Contractor shall schedule and hold a prefabrication meeting to coordinate specification and shop drawing issues prior to the first shop drawing submittal. Attendees shall include the Owner, Architect, General Contractor, Subcontractors related to this work.
 - c. Construction of systems including testing and adjusting as required and correcting deficient or defective operations and materials.

- C. Related Requirements:

1. Division 03 Section "Cast-in-Place Concrete."
2. Division 05 Section "Structural Steel Framing."
3. Division 05 Section "Galvanized Steel Animal Caging + Keeper Gates"

1.3 PRE-QUALIFIED METAL FABRICATORS AND INSTALLERS

- A. Only Subcontractors whose experience and workmanship that have been previously reviewed and pre-qualified by the Architect/Exhibit Designer for the Work of this Section. Qualifications for companies not listed herein include a minimum of five (5) years experience in metal work of this type, plus a minimum of three (3) similar projects involving containment of animals.

Companies requesting consideration shall submit written and photographic proof of previously performed projects.

- B. Subject to the compliance with the requirements of these Specifications, pre-qualified fabricators and installers for flexible woven wire mesh and rigging include, but are not limited to the following:

1. A thru Z Consulting and Distributing, Inc.
8620 E. Old Vail Road, Suite 100
Tucson, AZ 85747
Phone: (520) 434-8281
2. Nets Unlimited, Inc.
28248 N. Tatum Blvd., B1-450
Cave Creek, AZ 85331
Phone: (480) 515-1300
3. International Cordage, Inc.
2240 S. 17th Street
Phoenix, AZ 85034
Phone: (800) 920-1474

1.4 REFERENCES

- A. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes.
- B. ASTM A666 Standard Specification for Austenitic Stainless Steel sheet, strip, and flat bar.
- C. AWS D1.1 Structural Welding Code.
- D. FS TT P 645 Primer, Paint, Zinc Chromate, Alkyd Type.

1.5 FIELD MEASUREMENTS

- A. Prior to submission of shop drawings, the Specialty Mesh Subcontractor shall verify that all field measurements are as indicated on the Drawings and Schedules and notify the Architect in writing of any major discrepancies. No fabrication shall proceed until all inconsistencies are corrected.

1.6 SUBMITTALS

- A. Pre-detailing Conference: Contractor shall schedule and hold a prefabrication meeting to coordinate specification and shop drawing issues prior to the first shop drawing submittal. Attendees shall include the contractor's project manager, the detailer, the fabricator, the erector, the structural engineer of record and the testing agency.
- B. Submit Shop Drawings, Product Data, Field Mock-up and Samples to the requirements relevant to Division 01.
- C. Mesh Structure Shop drawings: Indicate layout, location, all dimensions for each of the mesh structures, and all tensioning requirements for each cable. Show all concrete details, steel reinforcing, steel erection details, connection details, and all miscellaneous steel fabrication details.

- D. Mesh Fabric Shop Drawings: Show all plans, elevations, cross-sections, and complete details of all anchoring methods, fastenings, mesh attachment methods, operable panel details, materials and methods for a complete installation for all structures.
 - E. Shop Drawings:
 - 1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 - 2. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.
 - 3. Caging Contractor to review and coordinate with steel fabrication drawings prior to submitting steel shop drawings and caging drawings to Architect and Engineer.
 - F. Product Data: Provide manufacturer's engineering data and other pertinent product data for wire rope, cables, turnbuckles, swage joints, eye nuts, etc.
 - G. Samples: Submit for review, one (1) representative samples of each of the following:
 - 1. Turnbuckles with 12" long piece of specified cable attached to indicate connection.
 - 2. Swage joints with 12" long piece of specified cable attached to indicate connection.
 - 3. Mesh - 18" x 18" samples of each type of mesh specified.
 - 4. Cables and woven wire rope - 30 inch long samples of each type specified.
 - 5. Hog rings, and any other miscellaneous attachment devices.
 - H. Production runs of all components shall be contingent on the results of the review process.
- 1.7 WARRANTY
- A. Submit the following written warranty:
 - 1. The fabricator/installer shall provide the Owner with a written warranty, signed and notarized, guaranteeing the materials, workmanship, and operation of the caging systems for a period of not less than one (1) year from the date of 'substantial completion.' This warranty shall be separate from any other materials or operations warranty that may or may not be supplied by any parts supplier or manufacturer. Any defective materials, inadequate operation, or general failure of the system or any portion thereof during the warranty period, shall be the sole responsibility for the fabricator/installer.
 - B. Replace any defective materials with new materials furnished by the fabricator/installer at no cost to the Owner if failure occurs during the warranty period.

1.8 FULL SCALE MOCK-UPS

- A. Immediately upon receipt of the notice-to-proceed with construction work, the Contractor shall be required to construct "mock-up" panels at the project site using exposed construction materials, bonding, tooling and reinforcement to be utilized in the actual construction. Obtain Architect's written approval of the "mock-up" panel prior to starting actual construction work. Provide mock-up panels as follows:
 - 1. Red Panda Mesh Panels: Minimum 48-inch by 48-inch panel demonstrating proposed attachment to wire rope cable; include turnbuckle and termination anchor shackle assembly.

2. Panel for Keeper Gates: One (1) of each type, full scale mesh panel and gate assembly utilizing mesh, keeper gates, framing and operating hardware and mechanisms indicated in the construction documents. Panel shall demonstrate actual workmanship and operation expected in the completed work.
- B. All mock-ups shall serve to demonstrate construction methods, operability (where required), finishes, etc.
 - C. Coordinate field reviews of all mock-ups with representatives of Owner and Architect. Make all adjustments required by the Owner and/or Architect at no additional cost to the Project. If significant adjustments are required, schedule an additional review with the required parties.
 - D. Obtain from the Owner and Architect written statements accepting mock-ups as the basis for construction of the respective assemblies and systems. Do not begin fabrication of any affected assemblies until written acceptance is obtained.
 - E. Do not alter, move or destroy "mock-up" panels until approval is granted or as otherwise directed by the Architect. Damage or destruction of the panel prior to approval shall be cause for its replacement at the expense of the Contractor.
 - F. Mock-ups may remain as part of the final work if accepted by the Owner and Architect. Mock-ups that are not to remain as part of the Final Work shall be dismantled and removed off-site.

PART 2 - PRODUCTS

2.1 MATERIALS FOR MESH STRUCTURE

- A. Concrete: Type specified in Division 03 Section "Cast-in-Place Concrete" to the requirements of the Structural Drawings.
- B. Structural Steel: Type specified in Division 05 Section "Structural Steel Framing."
- C. Miscellaneous Steel: Type Specified in Division 05 Section "Metal Fabrications." Miscellaneous steel items shall include, but are not limited to, the following:
 1. Continuous steel rods and steel studs that are welded to the structural as indicated for the purpose of attaching all steel mesh fabric.
 2. All other miscellaneous steel fabrications required for the complete and fully functional mesh structures system.
 3. Finish: As indicated on drawings.
- D. All materials are to be new and delivered to the site in an undamaged condition.
- E. Galvanized Products: Assemblies called out to be galvanized shall be galvanized after fabrication, per ASTM A-123.
- F. Assemblies called out to be stainless steel shall be Type 304

2.2 MATERIALS FOR STEEL MESH

- A. Steel Mesh Types: Stainless steel type mesh, and as indicated on the Drawings, as follows:

1. Type 304 stainless steel hand woven wire rope mesh with double hitch splice (tuck) at each connection. Maximum opening shall be measured from corner to corner when fully tensioned after installation. Black Oxide finish.
 - a. Mesh Enclosures:
 - 1) Habitat A: 1.5" x 1.5" x 1/16" mesh.
 - 2) Habitat B: 2" x 2" x 1/16" mesh.

2.3 MATERIALS FOR RIGGING

- A. Provide types and sizes as required for wire rope sizes indicated on the Structural Drawings, or per delegated design engineer, including, but not limited to the following:
 1. Cables.
 2. Turnbuckles.
 3. Swage sockets.
 4. Field adjustments.
 5. Anchor shackles.

PART 3 - EXECUTION

3.1 INSTALLATION OF STRUCTURAL WORK

- A. Install, erect, and tension all required structural work to the criteria of Division 05 Section "Structural Steel Framing" and the Structural Drawings.

3.2 INSTALLATION OF STEEL MESH

- A. Prior to installing any mesh, verify that all necessary structural work is finished and in place ready to receive work. Do not proceed with installation in areas of discrepancy until all such discrepancies have been resolved.
- B. Verify that field conditions are acceptable and are ready to receive work. Do not install until any unsatisfactory conditions are corrected. Beginning Work constitutes contractor's acceptance of conditions as satisfactory.
- C. Install all work in accordance with approved shop drawings.
- D. All loose ends of cables and mesh shall be finished with a double "NICO" press crimp, and ground smooth. No loose cable ends or sharp edges will be permitted.

3.3 PREPARATION OF STEEL ASSEMBLIES

- A. Verify dimensions on site prior to shop fabrication.
- B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- C. Fabricate steel assemblies as noted on structural drawings and to American Institute of Steel Construction standards.

- D. Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline. All oversized holes required for fabrication shall be welded & plugged. No holes, cavities, or other voids will be acceptable, unless specifically designed into the caging system.
- E. Continuously seal joined members by continuous welds.
- F. Fit and shop assemble in largest practical sections, for delivery to site.
- G. Exposed Mechanical Fastenings: Flush countersunk torx or hex socket machine screws and bolts; stainless steel finish; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- H. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius of 1/8". Radius all corners to 1/4".
- I. Galvanize items in accordance to ASTM A-123 and hardware to ASTM A-153.
- J. Do not prime surfaces in direct contact bond with concrete or where field welding is required. Prime paint items scheduled with one coat.

3.4 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. After installation, touch-up field welds, scratched or damaged surfaces with specified touch-up paint.
- C. Remove all sharp edges, burrs, corners and slivers that, in the opinion of the Architect, and/or Owner could injure animals or keepers.
- D. Apply specified sealant to all gaps in any of the following areas:
 - 1. Between adjacent construction.
 - 2. Where specifically detailed.
 - 3. Where required to comply with the Animal Management Requirements of Construction procedures listed elsewhere in this Specification Section.

3.5 WELDING REQUIREMENTS

- A. All exposed welds shall be ground smooth and galvanized.
- B. Remove all sharp edges, burrs, corners, and slivers, which in the opinion of the Architect and/or Owner, could injure animals or keepers.

3.6 ANIMAL MANAGEMENT AND REQUIREMENTS OF CONSTRUCTION

- A. As indicated in Division 01 Section "Animal Management Requirements of Construction" and as shown on drawings.

END OF SECTION 055968

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Wood-preserved-treated lumber.
3. Dimension lumber framing.
4. Miscellaneous lumber.

B. Related Requirements:

1. Section 061600 "Sheathing" for roof and wall sheathing.
2. Section 061753 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.

1.2 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
- C. Exposed Framing: Framing not concealed by other construction.
- D. Lumber grading agencies, and abbreviations used to reference them, include the following:
1. NeLMA: Northeastern Lumber Manufacturers' Association.
 2. NLGA: National Lumber Grades Authority.
 3. SPIB: The Southern Pine Inspection Bureau.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preserved treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 DELIVERY, STORAGE, AND HANDLING

- ##### A.
- Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. 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 wood products.
4. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:

1. Dimension Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1, Use categories as follows:

1. UC2: Interior construction not in contact with ground but may be subject to moisture. Include
2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
3. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
4. After treatment, redry dimension lumber to 19 percent maximum moisture content.

- ##### B.
- Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
 - 1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood sills, blocking, and similar concealed members in contact with masonry or concrete.

2.3 DIMENSION LUMBER FRAMING

- A. Joists, Rafters, and Other Framing by Grade: No. 1 grade.
 - 1. Species:
 - a. Douglas fir-larch (north); NLGA.
- B. Exposed Framing: Hand-select material indicated to receive a stained or natural finish for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 - 1. Species and Grade:
 - a. As selected above for load-bearing construction of same type.

2.4 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:
 - 1. Hem-fir (north); NLGA.
 - 2. Mixed southern pine or southern pine; SPIB.
 - 3. Spruce-pine-fir; NLGA.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

2.5 FASTENERS

- A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient

length, to penetrate not less than 1-1/2 inches into wood substrate.

1. Where rough carpentry is exposed to weather, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate blocking and similar supports to comply with requirements for attaching other construction.
- B. Do not splice structural members between supports unless otherwise indicated.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- D. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- E. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 1. Use inorganic boron for items that are continuously protected from liquid water.
- F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 2. ICC-ES evaluation report for fastener.
- H. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.
- I. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

- 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 wood blocking to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Attach wood roofing nailers securely to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with ANSI/SPRI ED-1, Tables A6 and A7.

3.3 INSTALLATION OF CEILING JOIST AND RAFTER FRAMING

- A. Rafters: Notch to fit exterior wall plates and toe nail or use metal framing anchors as indicated in drawings. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
 - 1. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches deeper. Bevel ends of jack rafters for full bearing against hip rafter.

3.4 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 061300 - HEAVY TIMBER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Timber.
 - 2. Miscellaneous materials.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for dimension lumber items associated with heavy timber framing.

1.2 DEFINITIONS

- A. Timbers: Lumber of 5 inches nominal or greater in least dimension.
- B. Inspection agencies, and the abbreviations used to reference them, include the following:
 - 1. NLGA: National Lumber Grades Authority.
 - 2. SPIB: Southern Pine Inspection Bureau (The).
 - 3. WCLIB: West Coast Lumber Inspection Bureau.
 - 4. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For heavy timber framing. Show layout, dimensions of each member, and details of connections.
- B. Samples: Not less than 24 inches long by full design width/depth, showing the range of variation to be expected in appearance, including surface texture, of wood products. Apply a coat of penetrating sealer to Samples.

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates:
 - 1. For timbers specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
- B. Certificates of Inspection: Issued by lumber-grading agency for exposed timber not marked with grade stamp.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Schedule delivery of materials to avoid extended on-site storage and to avoid delaying the Work.
- B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

PART 2 - PRODUCTS

2.1 TIMBER

- A. Comply with DOC PS 20 and with grading rules of lumber-grading agencies certified by ALSC's Board of Review as applicable.
 - 1. Factory mark each item of timber with grade stamp of grading agency.
 - 2. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that are not exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.
- B. Timber Species and Grade:
 - 1. Hem-fir or hem-fir (North); Select Structural, NLGA, WCLIB, or WWPA.
 - 2. Southern pine; Select Structural, SPIB.
- C. Moisture Content: Provide timber with 19 percent maximum moisture content at time of dressing.
- D. Dressing: Provide timber that is rough sawn (Rgh).

2.2 MISCELLANEOUS MATERIALS

- A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
- B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.3 FABRICATION

- A. Camber: Fabricate horizontal members with natural convex bow (crown) up, to provide camber.
- B. Coat crosscuts with end sealer.
- C. Seal Coat: After fabricating and surfacing each unit, apply a saturation coat of penetrating sealer on surfaces of each unit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Erect heavy timber framing true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
 - 1. Install horizontal members with crown edge up and provide not less than 4 inches of bearing on supports. Provide continuous members.
 - 2. Handle and temporarily support heavy timber framing to prevent surface damage, compression, and other effects that might interfere with indicated finish.
- B. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

3.2 ADJUSTING

- A. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber framing if repairs are not approved by Architect.

END OF SECTION 061300

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof sheathing.
2. Composite insulated wall sheathing with integral weather-resistive barrier.
3. Interior ceiling sheathing.
4. Sheathing joint-and-penetration treatment materials.

B. Related Requirements:

1. Section 044313.16 "Adhered Stone Masonry Veneer" for drainage mat applied over wall sheathing.
2. Section 07411.13 "Formed Metal Roof Panels" for underlayment installed on roof panels.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof sheathing.
2. Composite insulated wall sheathing.
3. Interior ceiling sheathing.
4. Sheathing joint-and-penetration treatment materials.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 ROOF SHEATHING

- A. Plywood Sheathing, Roofs: , Exposure 1, Structural I sheathing.

1. Span Rating: Not less than 40/20.

2.2 COMPOSITE INSULATED WALL SHEATHING

- A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1, Structural 1, with factory-laminated water-resistive barrier facer over oriented strand board on one face.
 - 1. Basis-of-Design Product: Provide Zip System R-Sheathing as manufactured by Huber Engineered Woods, LLC.
 - 2. Polyisocyanurate-Foam Thickness: Not less than 1-1/2 inches.
 - 3. Oriented-Strand-Board Nominal Thickness: Not less than 5/8 inch.
 - 4. Edge Profile: Square.
 - 5. Weather Barrier Facer: Medium-density, phenolic-impregnated sheet material; ASTM D779, Grade D weather-resistive barrier.

2.3 INTERIOR CEILING SHEATHING

- A. Plywood: DOC PS 1, Exterior, A-C.
 - 1. Span Rating: Not less than 24.
 - 2. Nominal Thickness: Not less than 23/32 inch.
 - 3. Edge Detail: Square.
 - 4. Surface Finish: Fully sanded face.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Composite Nail Base Insulated Wall Sheathing to Concrete or Masonry Wall: Type and length recommended by sheathing manufacturer for thickness of sheathing to be attached .

2.5 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Self-Adhering Seam and Flashing Tape: Pressure-sensitive, self-adhering, cold-applied, seam tape consisting of polyolefin film with acrylic adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
- D. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF WOOD STRUCTURAL PANEL

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Roof Sheathing:
 - a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of sheathing panels.
 - b. Space panels 1/8 inch apart at edges and ends.
 - 2. Composite Insulated Wall Sheathing:
 - a. Securely fasten to concrete or masonry substrate.
 - b. Space panels 1/8 inch apart at edges and ends.
 - c. Apply self-adhering seam tape to cover space between panels.
 - 3. Interior Ceiling Sheathing:
 - a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of sheathing panels.
 - b. Space panels 1/8 inch apart at edges and ends.

END OF SECTION 061600

SECTION 061753 - SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.

1.2 DEFINITIONS

- A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.

- B. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
5. Show splice details and bearing details.

- C. Delegated Design Submittals: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For metal connector-plate manufacturer, professional engineer, and fabricator.

- B. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.

- C. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss-fabricating firm.

D. Evaluation Reports: For the following, from ICC-ES:

1. Metal-plate connectors.
2. Metal truss accessories.

1.5 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program, complies with quality-control procedures in TPI 1, and involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in SBCA BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses.

B. Structural Performance: Metal-plate-connected wood trusses are to be capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

1. Design Loads: As indicated.
2. Maximum Deflection under Design Loads:

- a. Roof Trusses: Vertical deflection of **1/360** of span.
- C. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and SBCA BCSI.
- D. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

2.2 WOOD PRODUCTS

- A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Provide dressed lumber, S4S.
 - 4. Provide dry lumber with 15 percent maximum moisture content at time of dressing.
- B. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal for both top and bottom chords.
- C. Minimum Specific Gravity for Top Chords: 0.50
- D. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."

2.3 METAL CONNECTOR PLATES

- 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. Alpine, a division of ITW Inc.
 - 2. Cherokee Metal Products, Inc.; Masengill Machinery Company
 - 3. Eagle Metal Products
 - 4. MiTek Industries, Inc.
- B. Fabricate connector plates to comply with TPI 1.
- C. Hot-Dip Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 coating designation; and not less than 0.036 inch thick.
 - 1. Use for interior locations unless otherwise indicated.

2.4 FASTENERS

- A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
- B. Nails, Brads, and Staples: ASTM F1667.

2.5 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.
- C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
 - 1. Fabricate wood trusses within manufacturing tolerances in TPI 1.
- D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

2.6 SOURCE QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.
 - 1. Provide special inspector with access to fabricator's documentation of detailed fabrication and quality-control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.
 - 2. Provide special inspector with access to places where wood trusses are being fabricated to perform inspections.
- B. Correct deficiencies in Work that special inspections indicate do not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wood trusses only after supporting construction is in place and is braced and secured.
- B. If trusses are delivered to Project site in more than one piece, assemble trusses before

installing.

- C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- D. Install and brace trusses according to TPI recommendations and as indicated.
- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space trusses as indicated on drawings; adjust and align trusses in location before permanently fastening.
- G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.
- H. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
 - 1. Install bracing to comply with Section 061000 "Rough Carpentry."
- I. Install wood trusses within installation tolerances in TPI 1.
- J. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.
- K. Replace wood trusses that are damaged or do not comply with requirements.
 - 1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, when approved by Architect.

3.2 REPAIRS AND PROTECTION

- A. Protect wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Repair damaged galvanized coatings on exposed surfaces in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections to verify that temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

END OF SECTION 061753

SECTION 062013 - EXTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior trim.
2. Lumber soffits.

1.2 ACTION SUBMITTALS

A. Samples for Verification:

1. For each species and cut of lumber and panel products, with half of exposed surface finished; 50 sq. in. for lumber and 8 by 10 inches for panels.

1.3 INFORMATIONAL SUBMITTALS

A. Compliance Certificates:

1. For lumber that is not marked with grade stamp.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation.

1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
2. Provide for air circulation around stacks and under coverings.

1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecast weather conditions permit work to be performed and at least one coat of specified finish can be applied without exposure to rain, snow, or dampness.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of inspection agency, indicating grade, species, moisture content at time of surfacing, and mill.
 2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

2.2 EXTERIOR TRIM

- A. Lumber Trim for Transparent Finish (Stain or Clear Finish):
1. Species and Grade:
 - a. Hem-fir; NLGA, WCLIB, or WWPA 1 Common.
 - b. Southern pine; SPIB C & Btr.
 2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 3. Finger Jointing: Not allowed.
 4. Face Surface: Saw textured.

2.3 LUMBER SOFFITS

- A. Provide kiln-dried lumber siding complying with DOC PS 20.
- B. Species and Grade:
1. Hem-fir; NLGA, WCLIB, or WWPA 1 Common.
 2. Southern pine; SPIB C & Btr.
- C. Pattern:
1. V-edge, smooth-faced tongue and groove, actual face width (coverage) and thickness of 5-1/8 by 23/32 inch.

2.4 MISCELLANEOUS MATERIALS

- A. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches into wood substrate.
1. Provide stainless steel or hot-dip galvanized-steel fasteners.

- B. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.
- C. Continuous Soffit Vents: Aluminum hat channel shape with perforations, 2 inches wide and in lengths not less than 96 inches.
 - 1. Finish: Brown paint.

2.5 FABRICATION

- A. Back out or kerf backs of standing and running trim wider than 5 inches, except members with ends exposed in finished work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- B. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut exterior finish carpentry to fit adjoining work.
 - 3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 4. Coordinate exterior finish carpentry with materials and systems in or adjacent to it.
 - 5. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

3.4 INSTALLATION OF TRIM

- A. Install flat-grain lumber with bark side exposed to weather.
- B. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long, except where necessary.
 - 1. Use scarf joints for end-to-end joints.
 - 2. Stagger end joints in adjacent and related members.
- C. Fit exterior joints to exclude water.
 - 1. Cope at returns and miter at corners to produce tight-fitting joints, with full-surface contact throughout length of joint.
 - 2. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
- D. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.

3.5 ADJUSTING

- A. Replace exterior finish carpentry that is damaged or does not comply with requirements.
 - 1. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- B. Adjust joinery for uniform appearance.

3.6 CLEANING

- A. Clean exterior finish carpentry on exposed and semiexposed surfaces.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.

3.7 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062013

SECTION 071616 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Crystalline waterproofing.

B. Related Requirements:

1. Section 033713 "Shotcrete" for preparation and application of wet-mix concrete to receive waterproofing.

1.2 DEFINITIONS

- A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.
- B. Chemically Compatible: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.
- C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength, complying with specified performance requirements when in contact with another material.

1.3 COORDINATION

- A. Coordinate Work under this Section with adjacent concrete foundation Work, including other waterproofing systems.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including, but not limited to, the following:
 - a. Minimum concrete curing period.
 - b. Forecasted weather conditions.
 - c. Repairs.
 - d. Field quality control.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Statement: For Applicator.
- B. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample warranties.

1.7 QUALITY ASSURANCE

- A. Applicator Qualifications: Entity that employs applicators and supervisors who are trained and approved by waterproofing manufacturer in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.8 MOCKUPS

- A. Build mockups to set quality standards for materials and execution.
 - 1. Build mockup as indicated on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged waterproofing materials in original undamaged containers, with manufacturer's labels and seals intact.
- B. Store materials in dry environment at a temperature above 45 degrees F.
- C. Do not use materials stored for more than 24 months from date of manufacture.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be applied in accordance with manufacturer's written instructions and warranty requirements.
- B. Proceed with waterproofing work only after installation of pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have

been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

1.11 WARRANTY

A. Manufacturer's Material Warranty: Manufacturer agrees to replace waterproofing that fails to remain watertight within specified warranty period.

1. Warranty includes replacement of waterproofing system.
2. Warranty Period: Ten years from date of Substantial Completion.

B. Applicator's Special Warranty: Submit warranty signed by Applicator, to replace waterproofing that fails to remain watertight within specified warranty period covering Work of this Section.

1. Warranty includes leak remediation, and coverage for failure to meet specified requirements, including defects caused by faulty workmanship.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

A. Crystalline Waterproofing: Prepackaged, gray-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into exhibit rockwork shotcrete and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; with properties complying with or exceeding the criteria specified below.

1. 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:
 - a. ChemMasters, Inc
 - b. Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
 - c. Sika Corporation
 - d. Tremco Incorporated
2. Water Permeability: Maximum zero for water at 30 ft. when tested in accordance with COE CRD-C 48.
3. Compressive Strength: Minimum 4000 psi at 28 days when tested in accordance with ASTM C109/C109M.
4. Self-Sealing: Autogenous crack sealing of treated concrete for cracks with width of 0.02 inch or greater when subjected to hydrostatic pressure of 65 psi.
5. Sulfate Resistance: The waterproofing treatment must improve concrete resistance to sulfates by reducing permeability without affecting compressive strength; performance to be verified by independent testing.
6. Potable Water Containment: Products of this Section must be certified to NSF 61 for use with potable water.

2.2 ACCESSORY MATERIALS

- A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use.
- B. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended in writing by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.
- C. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended in writing by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.
- D. Water: Potable.

2.3 MIXES

- A. Crystalline Waterproofing: Add prepackaged dry ingredients to water in accordance with manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
- B. Proceed with application only after unsatisfactory conditions have been corrected.
- C. Notify Architect in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions.
- B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
- C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
- D. Stop active water leaks with plugging compound.

- E. Repair damaged or unsatisfactory substrate with patching compound.
 - 1. At holes and cracks 1/16 inch wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum 1 inch deep. Fill reveal with patching compound flush with surface.
- F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
 - 1. Clean shotcrete surfaces in accordance with ASTM D4258.

3.3 APPLICATION OF CRYSTALLINE WATERPROOFING

- A. General: Comply with waterproofing manufacturer's written instructions for application and curing.
 - 1. Saturate surface with water for several hours and maintain damp condition until applying waterproofing. Remove standing water.
 - 2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:
 - a. Onto every substrate in areas indicated for treatment, including pits sumpsand similar offsets and features.
 - 3. Number of Coats: Number required for specified water permeability.
 - 4. Application Method: Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
 - 5. Dampen surface between coats.
- B. Final Coat Finish: Spray textured.
- C. Curing: Moist-cure waterproofing for three days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.

END OF SECTION 071616

SECTION 072119 - FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Closed-cell spray polyurethane foam insulation.
 2. Accessories.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION

- A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 1.5 lb/cu. ft. and minimum aged R-value at 1-inch thickness of 6.2 deg F x h x sq. ft./Btu at 75 deg F.
1. 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:
 - a. Carlisle Spray Foam Insulation
 - b. Gaco; Holcim Building Envelope
 - c. Johns Manville; a Berkshire Hathaway company
 - d. Master Builders Solutions, brand of MBCC Group, a Sika company
 2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
3. Fire Propagation Characteristics: Passes NFPA 276 testing as part of an approved assembly.

2.2 ACCESSORIES

- A. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.
- B. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.2 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Spray insulation to envelop entire area to be insulated and fill voids.
- C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.
- D. Framed Construction: Install into cavities formed by framing members to achieve thickness indicated on Drawings.
- E. Miscellaneous Voids: Apply according to manufacturer's written instructions.

3.3 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 072119

SECTION 074113.13 - FORMED METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Corrugated-profile, exposed-fastener metal roof panels.
2. Underlayment.

1.2 COORDINATION

- A. Coordinate sizes and locations of roof penetrations with actual equipment provided.
- B. Coordinate metal roof panel installation with flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal roof panel Installer, metal roof panel manufacturer's representative, and installers whose work interfaces with or affects metal roof panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special details, penetrations, and condition of other construction that affect metal roof panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal roof panel systems during and after installation.
8. Review procedures for repair of metal roof panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 1. Include fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Verification: Actual sample of finished products for each type of exposed finish for metal roof panels, clips, fasteners, closures, and other metal panel accessories.
 1. Size: Manufacturers' standard size.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For formed metal roof panels, for tests performed by a qualified testing agency.
- B. Field quality-control reports.
- C. Qualification Statements: For roof installers.
- D. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal roof panels.

1.7 QUALITY ASSURANCE

- A. Roof Installer Qualifications: Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman and not less than 20 percent of installers who are NRCA ProCertified Metal Panel Roof Systems Installers.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal roof panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness, with positive slope for drainage of water. Do not store metal roof panels in contact with other

materials that might cause staining, denting, or other surface damage.

- D. Retain strippable protective covering on metal roof panels during installation.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed in accordance with manufacturers' written installation instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal roof panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal roof panel systems capable of withstanding the effects of the following loads when tested in accordance with ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Watertightness: No water penetration when tested in accordance with ASTM E2140 for hydrostatic-head resistance.

C. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 EXPOSED-FASTENER METAL ROOF PANELS, GENERAL

A. Provide factory-formed metal roof panels designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners. Include all accessories required for weathertight installation.

2.3 CORRUGATED-PROFILE, EXPOSED-FASTENER METAL ROOF PANELS

A. Basis-of-Design Product: Subject to compliance with Div. 01 requirements regarding substitutions, provide 7/8-inch corrugated metal roofing panels as manufactured by Western States Metal Roofing. A comparable product by one of the following may be considered:

1. Berridge Manufacturing Company
2. CENTRIA, a Nucor Brand
3. Fabral; a brand of Flack Global Metals
4. MBCI; Cornerstone Building Brands
5. Morin - A Kingspan Group Company

B. Metal Roof Panels: Formed with alternating curved ribs.

1. Structural Support: Over solid deck.
2. Material: Metallic-coated steel.
3. Rib Spacing: 2.67 inches o.c. across width of panel.
4. Panel Coverage: 34.67 inches.
5. Panel Height: 0.875 inch.
6. Fasteners: Manufacturer's standard screw fasteners.

2.4 METAL ROOF PANEL MATERIAL

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality. Sheet prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: 0.034 inch.
2. Surface: Smooth, flat texture.
3. Exterior Finish: four-coat Fluoropon print system.
4. Color: Streaked Rust.

2.5 UNDERLAYMENT

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.
1. 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:
 - a. Carlisle WIP Products; a brand of Carlisle Construction Materials
 - b. Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)
 - c. Owens Corning
 - d. SDP Advanced Polymer Products Inc.
 2. Thermal Stability: Stable after testing at 220 deg F; ASTM D1970/D1970M.
 3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970/D1970M.
- B. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

2.6 MISCELLANEOUS MATERIALS

- A. Roof Panel Accessories: Provide components required for a complete, weathertight roof panel system, including trim, fasciae,, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels (manufacturer recommends color of accessories to accompany Streaked Rust panels be Speckled Rust)..
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal roof panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels (manufacturer recommends flashing and trim to accompany Streaked Rust be Speckled Rust)..
- C. Roof Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- D. Roof Panel Sealants: Provide sealant types recommended by manufacturer that are

compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
2. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.7 FABRICATION

- A. Fabricate and finish metal roof panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide roof panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations that apply to design, dimensions, metal, and other characteristics of item indicated.
 1. Form exposed sheet metal accessories that are without oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 3. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal roof panel manufacturer.
 - a. Size: As recommended by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.8 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Roof Panels and Accessories:
 1. Four-Coat Fluoropon Print System: Fluoropolymer finish containing not less than

70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.
 1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
- B. Felt Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.
 1. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.

3.3 INSTALLATION OF FORMED METAL ROOF PANELS

- A. Install metal roof panels in accordance with manufacturer's written instructions in orientation, sizes, and locations indicated. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 1. Shim or otherwise plumb substrates receiving metal roof panels.
 2. Flash and seal metal roof panels at perimeter of all openings. Fasten with self-

- tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that are concealed by metal roof panels are installed.
3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal roof panel Work proceeds.
 6. Align bottoms of metal roof panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Steel Roof Panels: Use stainless steel fasteners for surfaces exposed to exterior; use galvanized-steel fasteners for surfaces exposed to interior.
 2. Copper Roof Panels: Use copper, stainless steel, or hardware-bronze fasteners.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal roof panel manufacturer.
- D. Exposed-Fastener, Metal Roof Panels: Fasten metal roof panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
1. Lap ribbed or fluted sheets one full rib. Apply bead of joint sealant at lapped panels. Apply panels and associated items true to line for neat and weathertight enclosure.
 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal roof panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
 5. Flash and seal panels with weather closures at perimeter of all openings.
- E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal roof panel system, including trim, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturer; or, if not indicated, provide types recommended in writing by metal roof panel manufacturer.
- F. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that are without buckling and tool marks, and that are true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

Space movement joints at a maximum of 10 ft., with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

- G. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 ft. on slope and location lines and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.13

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Silicone joint sealants.
 2. Nonstaining silicone joint sealants.
 3. Latex joint sealants.

1.2 ACTION SUBMITTALS

- A. Product Data:
1. Silicone joint sealants.
 2. Nonstaining silicone joint sealants.
 3. Latex joint sealants.
- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Manufacturers' special warranties.
- B. Installer's special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

1.6 FIELD CONDITIONS

- A. 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.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, 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 demonstrated by joint-sealant manufacturer, based on testing and field experience.

- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation
 - b. Sherwin-Williams Company (The)
 - c. Sika Corporation - Building Components
 - d. The Dow Chemical Company
 - 2. Use for joints between interior plumbing fixtures and adjacent non-porous construction.

2.4 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation
 - b. Sika Corporation - Building Components
 - c. Tremco Incorporated
 - 2. Use for exterior joints between different materials.

2.5 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation
 - b. Sherwin-Williams Company (The)
 - c. Tremco Incorporated
 - 2. Use for interior joints between different materials.

2.6 JOINT-SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

2.7 MISCELLANEOUS MATERIALS

- A. 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 to joint substrates.
- B. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

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 performance of the Work.
- B. 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 all 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), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, 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 after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with

adhesion of joint sealants. Nonporous joint substrates include the following:

- a. Metal.
 - b. Glass.
 - c. FRP
- B. 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 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.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. 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.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess sealant 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.

3.5 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, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081613 - FIBERGLASS DOORS & FRAMES

PART 1 - GENERAL

1.1 SCOPE AND DEFINITIONS

- A. Furnish and install doors, frames of FRP composite construction in accordance with details and schedule shown on the project drawings and as specified herein..
- B. FRP is defined as "Fiberglass Reinforced Polyester"

1.2. RELATED SECTIONS

- A. Section 087100: Hardware
- B. Section 088000: Glazing

1.3 QUALITY ASSURANCE

- A. Experience: Manufacturer shall be ISO 9001 certified and been engaged in the manufacture of FRP door and frame systems for a minimum of five (5) years documented experience prior to the start of this work, and who has a history of successful production acceptable to the Architect.
- B. Process: Certify that FRP doors are manufactured via press-molding technology.
- C. Warranty: Provide written limited guarantee for FRP doors and frames as follows:
 - 1. Heavy Duty doors are guaranteed for the life of the product against delamination and failure due to products are inspected prior to shipment and guaranteed against defective workmanship for a period of ten (10) calendar years after the date of purchase.

1.04 SUBMITTALS

- A. Product Data: Provide catalog cut of FRP door detailing internal construction and reinforcements, materials used and description of molding process.
- B. Shop Drawings: To include the following specific information:
 - 1. Specifications relating to FRP door thickness, resin type, core material, method of construction, finish color, type of glass and glazing, anchor systems, joint construction and complete warranty information.
 - 2. Complete schedules or drawings of FRP doors and frames (and associated Builders Hardware) showing identifying mark numbers, door and frame types, typical elevations, nominal sizes, handing, actual dimensions and clearances, and required hardware preps and reinforcements.
 - 3. Supporting reference drawings pertaining to frame mounting details, door light or louver installation, hardware locations, and factory hardware cutouts and reinforcements.
- C. Color Samples: Provide a complete set of available finish colors from the manufacturer for color

selection upon request.

- D. Installation instructions: Include manufacturer's specific information describing procedures, sequence and required fasteners for frame and door installation.
- E. Production of FRP doors and frames shall not proceed until final approval of submittals and all necessary manufacturing information is received from customer.

1.05 DELIVERY, STORAGE AND HANDLING

- A. FRP doors and frames are to be delivered to jobsite in adequate crating with foam sheet separations between all components.
- B. Handling and storage of the doors and frames after receipt is the responsibility/liability of the customer. Store indoors in a vertical position, clear of the floor, with blocking between the doors to permit air circulation between the doors and prevent damage to the door faces. Rain/water or condensation must not be allowed to collect or lay between stored doors. Do not wrap in plastic sheeting.
- C. Use care in handling FRP doors and frames to prevent damage to factory finishes. Wear protective gloves and do not slide or drag doors or frames against one another.

PART 2 - PRODUCTS

2.01 Manufacturer

- A. FRP Doors and Frames shall be as manufactured by Tiger Door, 5224 FM 802 Brownsville, TX 78521 ph 888.891.4416 Website: www.tigerdoor.com. FRP DOORS

2.02

A. Heavy Duty FRP Doors

1. Design: FRP doors shall be of seamless press-molded construction. Laminated FRP face sheets shall be applied while wet and uncured to an internal door stile and rail subframe/core assembly and then press- molded under heat and pressure. The composite door panel must be integrally fused over its entire surface area, not just adhesive-bonded at perimeter stiles and rails. Doors shall remain under pressure during curing for flat, warp-free surfaces.
2. Stiles & Rails: A high-modulus pultruded FRP square or rectangular tube subframe is to be provided within the door. Tubes are to be mitered and joined internally at the corners with solid polymer blocks to yield a one-piece unit that does not require any secondary external sealing. Provide a tubular midrail across width of door at lock height, and additional horizontal rails where specific design conditions dictate. Doors shall incorporate molded-in FRP edge strips, chemically bonded to the subframe stiles, for machining of hardware mortises so as not to cut or otherwise compromise the integrity of the pultruded stiles, nor allow moisture to penetrate into the core of the door. All connections shall be chemically welded. No mechanical fasteners will be allowed. The use or inclusion of aluminum, steel, gypsum or wood into stile and rail construction is not permitted.
3. Core: For maximum rigidity and compressive strength a triangular shaped 3/8" cell phenolic resin impregnated kraft paper honeycomb core shall be used. Molding pressure and resin gel time shall be sufficient to allow for penetration of resin into the cellular structure of the core to maximize shear and peel strengths at the skin/core interface and eliminate the possibility of

delamination. The honeycomb is to be completely enclosed within the stile and rail subframe. Use of foam or balsa wood is not permitted.

4. Internal Reinforcement: High-modulus pultruded tubular FRP, high-density polymer compression blocks, or plastic compression blocking at all hardware locations, and corner locations. No wood blocking, steel or aluminum reinforcing plates, ribs or fittings shall be used. A minimum of 900 lbs of pullout strength is required for each factory supplied hinge screw.
5. Faces: Door facings shall utilize a chemical resistant thermosetting polyester resin system with fiber reinforcing layers. Supplier shall furnish door faces as shown on the drawings and in the door elevations. Chopped strand mat layers shall be used to provide bond integrity between gelcoat, laminated facings and the internal door structure. Structural reinforcement shall be in the form of a knitted multi-layer material with layers of uni-directional glass fiber oriented in both the vertical and horizontal directions for high stiffness, impact resistance and resistance to warping. Gelcoat surface integrally molded to be 25/30 mils thick (wet) ultra-violet light stabilized marine grade NPG-isophthalic polyester gelcoat.
6. Finish: The exposed FRP door faces shall have a 3-4 mils (wet) factory applied two-part aliphatic polyurethane fully cured coating of industrial urethane. Coating shall have a minimum hardness of H to 2H. Finish shall be a slightly textured semi-gloss to minimize the visual effects of wear and tear.
7. Lights: Glass per job specification shall be factory furnished, glazed and installed. Glazing shall be installed against a molded-in 5/8" wide exterior face flange with a bed of tape caulk, square 5/8" pultruded glazing stops with stainless steel screws shall complete the installation to secure the glazing in place. All glazing stop material shall be pultruded FRP with a minimum fiberglass content of 50%. Metal, pvc, or vinyl "Glass Kit" type lights are not acceptable.
8. Provisions for lights shall be performed during manufacture and shall not be attempted in the field. Cutouts are to be totally enclosed by pultruded FRP stiles and rails incorporated into the door structure. Light cutouts that expose core material are not acceptable. Factory prepare for 1-inch thick insulating glazing.

2.03 FRP FRAMES

A. FRP Frames:

1. Design: FRP Door frames furnished under this specification shall utilize a high-modulus pultruded structural FRP shape. The frame section shall be standard double rabbeted 5-3/4" deep x 2" face, 3/16" thick, with integral 5/8" doorstop with 1 15/16" soffits, to match typical hollow metal configurations.
2. Corner Joints: Frame jambs and header shall be joined at corners via miter connections with hidden FRP angle clips and associated fasteners. Post and beam corners will not be acceptable. Exposed fasteners for miter connections will not be acceptable except for wrap wall applications.
3. Hardware Reinforcements: FRP reinforcing shall be chemically welded to door frame material at required locations. Minimum screw pullout strength of 1100 lb per #12 x 1" sheet metal screw is required. Mechanically fastened reinforcements are not permitted.
4. Anchors:
 - a. GROUT-IN: Provide manufacturer's required number of wire or strap type anchors for installation into wall. Fill frame cavity with grout.
5. Finish: Frames shall have a 3-4 mils (wet) factory applied two-part aliphatic polyurethane fully cured coating of industrial urethane. Industrial urethane chemical coating color topcoat, to match the color and sheen of the doors, for superior weatherability. Gelcoat may not be sprayed onto the frame as a secondary coating.

2.4 FASTENERS

- A. All fasteners for all hardware shall be type 304 CRSS (18-8 series corrosion resistant stainless steel) with no exception. No carbon steel or aluminum components shall be used.

2.5 HARDWARE

- A. Hardware shall be furnished as listed in section 087100 or as so designated in appropriate section and shall be coordinated by GC and installed by experienced mechanics.
- B. Supplier shall furnish manufacturer's standard templates, installation instructions, or full size approved door and frame preparation instructions as approved by the architect and as required by door and frame manufacturer prior to door and frame factory initiated manufacture. Standard factory lead-time for production of FRP doors and frames shall commence only and when all distributor required preparation information is received and acknowledged by the door and frame manufacturer.

PART 3 - EXECUTION

3.01 IDENTIFICATION

- A. Factory mark all doors and frames using a chemical resistant plastic tag or indelible marker with identifying number, keyed to shop drawings, prior to shipment.

3.02 INSTALLATION

- A. Frames: Install in strict accordance with manufacturer's printed instructions. Set plumb and square, using shims for bolt-in of existing openings, or wood bracing prior to grouting of jambs. Use at least two 2x6 wood spreaders inside frame to maintain critical opening dimensions during grouting.
- B. Doors: Hang per manufacturer's printed instructions using special screws provided for hinge attachment. Install doors to swing freely and to stand open at any angle. After installation make final adjustments to hardware to allow for proper door operation and latching. All surface applied hardware shall be thru bolted.

3.03 CLEANING

- A. Clean exposed surfaces of FRP doors and frames with a mild, non-abrasive cleaner and water.

END OF SECTION 081613

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.

1.2 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:
 - a. Identification number, location, hand, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Fastenings and other installation information.
 - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - f. Mounting locations for door hardware.

- g. List of related door devices specified in other Sections for each door and frame.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware schedule.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to Owner by registered mail or overnight package service.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
- 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
 - a. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOJ's "2010 ADA Standards for Accessible Design", ICC A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.3 CONTINUOUS HINGES

- A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- thick, hinge leaves with minimum overall width of 4 inches; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
- B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies
 - b. Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY
 - c. STANLEY; dormakaba USA, Inc.
 - d. Zero International; Allegion plc

2.4 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.

- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
- C. Lock Backset: 2-3/4 inches unless otherwise indicated.
- D. Lock Trim:
 - 1. Levers: .
 - a. Match Best Lever #3.
 - 2. Escutcheons (Roses): Match Best Rose "S".
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
- F. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BEST Access Solutions, Inc.; dormakaba USA Inc.
 - b. SARGENT Manufacturing Company; ASSA ABLOY
 - c. Yale Security Inc; ASSA ABLOY

2.5 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
 - 1. Core Type: Interchangeable.

2.6 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.
 - 1. Master Key System: Change keys and a master key operate cylinders.
 - a. Provide three cylinder change keys and five master keys.
 - 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver or Brass.

2.7 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc
 - b. Rixson Specialty Door Controls; ASSA ABLOY
 - c. STANLEY; dormakaba USA, Inc.

2.8 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASI-American Specialties, Inc.
 - b. Hager Companies
 - c. Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY
 - d. Trimco

2.9 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY
 - b. Reese Enterprises, Inc
 - c. Zero International; Allegion plc

2.10 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY
 - b. Reese Enterprises, Inc

- c. Zero International; Allegion plc

2.11 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location .
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.12 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. FRP Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at required to comply with governing regulations.
- B. Install each door hardware item to comply with manufacturer's written instructions.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Thresholds: Set thresholds for exterior doors in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- E. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 1. Do not notch perimeter gasketing to install other surface-applied hardware.

3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.

- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass products.
 - 2. Laminated glass.
 - 3. Insulating glass.
 - 4. Miscellaneous glazing materials.

1.2 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of the following products; 12 inches square.

1. Laminated glass.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For glass.
- C. Product Test Reports: For fabricated glass, for tests performed by a qualified testing agency.
- D. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

- A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved and certified by primary glass manufacturer.
- B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.10 WARRANTY

- A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace

insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Glass: Obtain coated glass from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
 1. Design Wind Pressures: As indicated on Structural Drawings.
 - a. Wind Design Data: As indicated on Structural Drawings.
 2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
 3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 1. For laminated-glass lites, properties are based on products of construction indicated.
 2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Thickness: Where glass thickness is indicated, it is a minimum.
- D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. . Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian Glass LLC
 - b. Pilkington North America; NSG Group
 - c. Saint-Gobain Glass Corp
- B. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian Glass LLC
 - b. Pilkington North America; NSG Group
 - c. Saint-Gobain Glass Corp
- C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 LAMINATED GLASS

- A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pilkington North America; NSG Group
 - b. Saflex; Eastman
 - 2. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
 - 3. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 4. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 - 2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
 - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks:
 - 1. EPDM with Shore A durometer hardness of 85, plus or minus 5.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- D. Spacers:
 - 1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- E. Edge Blocks:
 - 1. EPDM with Shore A durometer hardness per manufacturer's written instructions.

2. Type recommended in writing by sealant or glass manufacturer.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep systems.
 3. Minimum required face and edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- D. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- E. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch- minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- F. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.
- G. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- H. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.5 LAMINATED GLASS SCHEDULE

A. Clear Laminated Glass Type : Two plies of low-iron fully tempered float glass.

1. Minimum Thickness of Each Glass Ply: 12 mm.
2. Interlayer Thickness: 0.090 inch.
3. Safety glazing required.

3.6 INSULATING GLASS SCHEDULE

A. Clear Insulating Glass Type :

1. Overall Unit Thickness: 1 inch.
2. Minimum Thickness of Each Glass Lite: 6 mm.
3. Outdoor Lite: Fully tempered float glass.
4. Interspace Content: Air.
5. Indoor Lite: Fully tempered float glass.
6. Safety glazing required.

END OF SECTION 088000

SECTION 092400 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal lath.
 - 2. Accessories.
 - 3. Base-coat cement plaster.
 - 4. Cement plaster finish coats.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
- B. Samples for Initial Selection: For each type of factory-prepared finish coat and for each color and finish texture specified.
- C. Samples for Verification: For each type of factory-prepared finish coat and for each color and finish texture specified, 12 by 12 inches, and prepared on rigid backing.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.5 FIELD CONDITIONS

- A. Comply with ASTM C926 requirements.
- B. Exterior Plasterwork:
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 - 2. Apply plaster when ambient temperature is greater than 40 deg F.
 - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster

coat has occurred.

PART 2 - PRODUCTS

2.1 METAL LATH

- A. Expanded Metal Lath: ASTM C847; cold-rolled carbon steel sheet, hot-dip galvanized with ASTM A653/A653M G60 zinc coating.
 - 1. 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:
 - a. AMICO, a Gibraltar Industries company
 - b. CEMCO; California Expanded Metal Products Co.
 - c. ClarkDietrich
 - d. Marino\WARE
 - e. Phillips Manufacturing Co
 - 2. Self-Furring Diamond-Mesh Lath: V-grooved.
 - a. Weight: 3.4 lb/sq. yd.

2.2 ACCESSORIES

- A. General: Comply with requirements in ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. DRAINAGE MAT
 - 1. Drainage Mat: Free-draining polymer-strand mesh sheets or strips with thickness not less than 1/4 inch and installed to full height of wall, to maintain a continuous open space behind cement plaster installation.
 - a. Manufacturers: Provide the same product, from one of the manufacturers listed below, as selected for use behind Adhered Stone Masonry Veneer.
 - 1) Mortair Vent 202 – Advanced Building Products, Inc.
 - 2) Rainscreen Mat WS – CavClear; a division of Archovations, Inc.
 - 3) Rainscreen Drainage and Ventilation Mat – Huver Engineered Woods LLC.
 - 4) Lathnet - Mortar Net Solutions,
- C. Metal Accessories:
 - 1. 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:
 - a. AMICO, a Gibraltar Industries company

- b. CEMCO; California Expanded Metal Products Co.
 - c. ClarkDietrich
 - d. Marino\WARE
 - e. Phillips Manufacturing Co
- 2. Foundation Weep Screed: Fabricated from hot-dip-galvanized steel sheet with ASTM A653/A653M G60 zinc coating.
 - 3. Cornerbeads: Fabricated from zinc-coated (galvanized) steel.
 - a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
 - 4. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
 - 5. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on exposed face of control joint.

2.3 BASE-COAT CEMENT PLASTER

- A. General: Comply with requirements in ASTM C926 for applications indicated.
 - 1. Aggregate:
 - a. Sand: Use unless otherwise indicated.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
 - 1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

2.4 CEMENT PLASTER FINISH COATS

- A. Acrylic-Based Finish Coatings: Factory-mixed, acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
 - 1. 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:
 - a. Dryvit Systems, Inc.
 - b. El Rey Stucco Solutions; a Parex USA, Inc. brand
 - c. Senergy; a SIKA brand

- d. Sto Corp.
- e. Stuc-O-Flex International, Inc.

- 2. Color: As selected by Architect from manufacturer's full range.
- 3. Texture: As selected by Architect from manufacturer's full range.
- 4. Source Limitations: Obtain acrylic-based finish coating from single source from single manufacturer.

2.5 PLASTER MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I.
 - 1. Color for Finish Coats: Gray.
- B. Lime: ASTM C206, Type S; or ASTM C207, Type S.
- C. Sand Aggregate: ASTM C897.

2.6 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Bonding Compound: ASTM C932.
- C. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Reject plaster materials that are wet or moisture damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster in accordance with ASTM C926.

3.3 INSTALLATION OF METAL LATH

- A. Drainage Mat: Install drainage mat over sheathing and foundation weep screed.
- B. Metal Lath: Install over drainage mat and sheathing in accordance with ASTM C1063.

3.4 INSTALLATION OF ACCESSORIES

- A. Install in accordance with ASTM C1063 and at locations indicated on Drawings.
- B. Reinforcement for External (Outside) Corners:
 - 1. Install cornerbead at exterior locations.
- C. Control Joints: Locate as approved by Architect for visual effect and as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft..
 - b. Horizontal and Other Nonvertical Surfaces: 100 sq. ft..
 - 2. At distances between control joints of not greater than 18 ft. o.c.

3.5 APPLICATION OF BASE-COAT CEMENT PLASTER

- A. General: Comply with ASTM C926.
 - 1. Install so that finished plaster surfaces will not deviate more than plus or minus 1/4 inch in 10 ft. from a true plane when measured by a 10-ft. straightedge placed on surface.
 - 2. Install so finished plaster surfaces will be flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets.
- B. Wall/Vertical Base Coats:
 - 1. Two-Coat Plasterwork Over Solid Plaster Bases: Install base-coat mix for use over solid plaster bases in minimum 3/4-inch thickness over sheathing.

3.6 APPLICATION OF CEMENT PLASTER FINISH COATS

- A. General: Comply with ASTM C926.
 - 1. Do not deviate more than plus or minus 1/4 inch in 10 ft. from a true plane in finished plaster surfaces when measured by a 10-ft. straightedge placed on surface.
 - 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does

not terminate plaster at metal frame, groove finish coat at junctures with metal.

- B. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, in accordance with manufacturer's written instructions.

3.7 REPAIR

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.8 CLEANING

- A. Remove temporary protection and enclosure of other work after plastering is complete.
- B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.
- C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092400

SECTION 099301 - STAINING AND TRANSPARENT FINISHING (MPI STANDARDS)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Staining and transparent finishing of exterior wood surfaces.

B. Related Requirements:

1. Section 099600 "High-Performance Coatings" for transparent high-performance coatings on concrete floors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
2. Include preparation requirements and application instructions.
3. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
4. Indicate VOC content.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of product.

C. Samples for Verification: For each type of finish system and in each color and gloss of finish required.

1. Submit Samples on representative samples of actual wood substrates, 8 inches long.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same product run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: 5 percent, but not less than 1 gal. of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than 5 deg F above the dew point, or to damp or wet surfaces.
- C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 STAINING AND TRANSPARENT FINISHING (MPI STANDARDS)

- A. Products: Subject to compliance with requirements, provide one of the products listed in wood finish systems schedules for the product category indicated.

2.2 SOURCE LIMITATIONS

- A. Source Limitations: Obtain each coating product from single source from single manufacturer.

2.3 MATERIALS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- C. Stain Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 - 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
 - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
- C. Exterior Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Prime edges, ends, faces, undersides, and backsides of wood.
 - a. For varnish-coated stained wood, stain edges and ends and prime with varnish. Prime undersides and backsides with varnish.
 - 3. Countersink steel nails, if used, and fill with putty or plastic wood filler tinted to final color. Sand smooth when dried.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for finish and substrate indicated.

- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

- A. Wood Substrates, Exposed Framing, Wood Trim, Lumber Soffits:
 - 1. Varnish over Stain System:
 - a. Stain Coat: Stain, exterior, solvent based, semitransparent, MPI #13.
 - 1) Benjammin Moore Arborcoat, Exterior Oil Stain – Semi-transparent.
 - 2) PPG Flood Pro Series, Semi-transparent alkyd/oil stain.
 - b. First Intermediate Coat: Varnish matching topcoat.
 - c. Second Intermediate Coat: Varnish matching topcoat.
 - d. Topcoat, Semigloss: Varnish, with UV inhibitor, exterior (MPI Gloss Level 5), MPI #30.
 - 1) Sherwin Williams Minwax, Helmsman Spar Varnish.

END OF SECTION 099301

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:
 - 1. Exterior Substrates:
 - a. Galvanized metal.
 - 2. Interior Substrates:
 - a. Concrete, vertical and horizontal surfaces.
 - b. Wood.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.3 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. Coatings: 5 percent, but not less than 1 gal. of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL

- A. Products: Subject to compliance with Div. 01 requirements regarding substitutions, provide product listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated. A comparable product by one of the manufacturers included in the "MPI Approved Products List" for specific application may be considered.
- B. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- C. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
 - 3. Products shall be of same manufacturer for each coat in a coating system.
- D. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance

of the Work.

- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Wood: 15 percent.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi at 6 to 12 inches.
- E. Galvanized-Steel Substrates: Remove grease and oil residue from galvanized steel by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
- F. Wood Substrates:
 - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer that is recommended in writing by topcoat manufacturer for coating system indicated.
 - 2. Sand surfaces that will be exposed to view and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with filler that is recommended in writing by topcoat manufacturer for coating system indicated. Sand smooth when dried.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.5 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Galvanized-Steel Substrates:
 - 1. Pigmented Polyurethane over Vinyl Wash Primer and Epoxy Primer System:
 - a. Prime Coat: Primer, vinyl wash, MPI #80.
 - 1) Sherwin Williams Industrial Wash Primer.
 - b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - 1) Sherwin Williams Dura-Plate 235 Multi-Purpose Epoxy.
 - c. Topcoat: First and Second Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

- 1) Sherwin Williams Acrolon 218 HS.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:

1. Epoxy-Modified Latex System:

- a. Prime Coat: Epoxy-modified latex, matching topcoat.
- b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
- c. Topcoat:

- 1) Epoxy-modified latex, gloss (MPI Gloss Level 6), MPI #115.

- a) Sherwin Williams Pro Industrial Water-Based Catalyzed Epoxy.

B. Concrete Substrates, Horizontal Surfaces.

1. Clear, Penetrating Silicone System:

- a. Prime Coat: N/A.
- b. Intermediate Coat: Penetrating Silicone Sealer, matching topcoat.
- c. Topcoat: Epoxy, gloss, MPI #117.

- 1) Sherwin Williams ConFlex Siloxane Water Repellant.

C. Wood Substrates: Wood trim and wood board paneling.

1. Epoxy System:

- a. Prime Coat: Epoxy, matching topcoat.
- b. Intermediate Coat: Epoxy, matching topcoat.
- c. Topcoat: Epoxy, gloss, MPI #77.

- 1) Sherwin Williams Pro Industrial High Performance Epoxy.

END OF SECTION 099600

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 REFERENCES

- A. All Provisions of this Section 220500 shall apply to all Sections of Division 22.
- B. The work of Division 22 includes providing all labor, material and equipment required to produce the various systems complete and operating.
- C. All work under this Division shall be subject to all applicable requirements of the Project Manual.
- D. The commissioning responsibilities found elsewhere in this project manual are applicable to this section.

1.2 CONTRACTOR'S INSTALLATION DRAWINGS

- A. Only drawings bearing Architect's stamp shall be used for construction. Keep drawings on job at all times.

1.3 MATERIAL AND EQUIPMENT REQUIREMENTS

- A. ALL products used on the project must be Asbestos FREE. Note, imports from Canada can contain asbestos and may state it is asbestos free but if the ingredients are checked it may contain chrysolite or Canadian fibers which is not considered asbestos in Canada but is considered asbestos here in the United States. This can be found in mastics, flooring products, and sheetrock. The Contractor shall be required to be aware of the products their company, and their subcontractors supply for the project. Contractor's shall be required to prudently check material MSDS sheets. Key words to look for include: asbestos, Canadian fibers, and Chrysolite mineral fibers.
- B. No materials or equipment shall be used in the work until reviewed and accepted for such work by the Engineer. Prior to submission of shop drawings, and within the time specified in Section 013300, the Contractor shall submit to the Engineer, a complete list of materials and equipment which he intends to furnish, giving manufacturer and catalog numbers. Shop drawings will not be considered for review until the complete list of the manufacturers of all materials and equipment has been accepted.
- C. All materials and equipment shall be new and the best of their respective kinds, suitable for the conditions and duties imposed on them after installation. All applicable materials and equipment shall be such as found in the approved list of the National Board of Fire Underwriters. Where applicable, all materials and equipment used shall bear the label of the Underwriter's Laboratories, Inc. securely attached.
- D. All equipment shall be supplied to the job in sections which can readily pass through the openings provided. If necessary, sections shall be assembled and connected at the site, within the space which they occupy.
- E. Only those materials and equipment named in the specifications by giving the name of the manufacturer, or by brand or trade name or catalog reference, shall be used as a basis for the

preparation of the base proposal, and only those materials shall be furnished under the Contract.

- F. Should the bidder desire to use any materials or products other than those specified by name, he shall submit the proposed substitution to the Engineer for review ten (10) days prior to the date of the proposal.
- G. Where substitutions are allowed herein, any equipment so accepted shall meet all specified requirements in all aspects of design, space requirements, electrical characteristics, power consumed, and suitability to system design. Any changes in wiring, controls, etc., from that shown on the contract drawings necessary to accommodate the equipment substituted shall be made by the Contractor at his expense. Where substitutions require change in the work under other sections, the Contractor shall make all such changes at his expense. Acceptance of the shop drawings of the substitution does not relieve the Contractor of this responsibility.
- H. Material list shall be submitted within thirty (30) days after award of contract.

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Section 013300.
- B. The Contractor shall submit shop drawings to the Engineer for review before fabrication of any equipment.
- C. Shop drawings, cuts, sheets, and other data shall bear the Contractor's stamp of approval as an indication that he has examined them and found thereon complete information as to the space requirements, electrical characteristics, power consumption, suitability to system design, and considers the material or equipment to fully meet the specifications.
- D. Review of shop drawings will be general and will not relieve the Contractor from the responsibility for quantities, for proper fitting and construction of the work, or from furnishing materials and work required by the contract which may not be indicated on the shop drawings when accepted.
- E. All materials and equipment shall be new, of best quality and grade, all subject to Engineer's review. None shall be used until they have been reviewed. Use product of one manufacturer where two or more items of same kind of equipment are required. Reuse existing equipment only where specifically indicated.
- F. Submit under provisions of Section 013300 a list of proposed manufacturer's and suppliers of all items of mechanical equipment for the Engineer's review. Submittals will not be processed until this list has been reviewed.

1.5 REGULATIONS AND PERMITS

- A. Perform all work in accordance with the applicable regulations of N.F.P.A., all State and Municipal building ordinances, codes and regulations and any insuring agency having jurisdiction.
- B. Furnish required certificates of approval. Obtain and pay for all required fees, permits and inspections.
- C. Within 30 days after award of Contract, make application for inspection service, simultaneously filing a copy of the application with the Architect as proof of having requested this service.

1.6 GUARANTEES

- A. Guarantee complete mechanical installation free of all defects of material, equipment and workmanship for one year beginning from date of final acceptance of work. During this year be responsible for proper adjustment of all systems, equipment and devices installed by Contractor and correct all defects or maladjustments promptly without additional expense to Owner. This shall not include normal maintenance, care and operation of the systems.
- B. Contractor's attention is directed to guarantee periods greater than one year on certain items of equipment. These requirements are spelled out in detail in the Articles covering the specific equipment.

1.7 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish manual containing a brief description of each system. Include explicit instructions for operating the systems. Provide under provisions of Section 017823.
- B. In addition, furnish the following information in the manual:
 - 1. Manufacturer's printed operating and maintenance instructions, parts lists, illustrations and diagrams for each piece of equipment.
 - 2. A complete schedule of periodic servicing and lubrication requirements for all equipment.
 - 3. Manufacturer's data report form U-1 certifying Code compliance for each piece of equipment specified to be constructed in accordance with ASME Code for Unfired Pressure Vessels.
 - 4. One copy of each shop drawing and Contractor's record drawings, and record control diagrams.
 - 5. One copy of Valve chart.
- C. Place these instructions in Architect's hands at least 30 days prior to date system will be turned over to Owner.
- D. After review by Architect, revise as required, and supply copy to Owner and Architect.

PART 2 PRODUCTS

2.1 ELECTRICALLY OPERATED EQUIPMENT AND CONTROLS

- A. Unless otherwise indicated:
 - 1. All starters, all disconnect switches and all work pertaining to equipment power connections are specified under Division 26, Electrical Work.
 - 2. All control circuit wiring, including all electrical interlocking, relay wiring, remote controls and temperature controls shall be provided under Division 23, and shall be in conformance with the requirements of Division 26.
 - 3. Provide all control devices suitable for operation on a maximum of 120 volt service.
 - 4. Where applicable, all equipment used shall bear the label of the Underwriter's Laboratories, Inc. securely attached.

PART 3 EXECUTION

3.1 WORKMANSHIP

- A. Install all materials and equipment in a neat and workmanlike manner. When directed, remove, replace, at Contractor's expense, all work not presenting an orderly, reasonable neat or workmanlike appearance or work failing to meet performance requirements.
- B. Coordinate all work and cooperate with other trades in building to facilitate proper and intelligent execution of work.

3.2 MANNER OF INSTALLATION

- A. Install all piping and equipment to permit easy access to all valves, dampers, traps and other equipment requiring periodic servicing. Provide extension devices and remote operators as necessary for all valves and lubrication points which require frequent service, adjustment or control and which cannot be located in a readily accessible and safe place.
- B. Unless otherwise directed, or in mechanical rooms, conceal all piping. In all cases, install piping to follow lines of building and to allow maximum headroom consistent with proper pitch.

3.3 PROTECTION OF THE WORK:

- A. Cover openings in piping and temporarily seal to protect from contamination.
- B. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water using raised platforms.
- C. Protect unfinished work at the end of each work day from damage contamination and moisture, by the use of plugs, caps, or covers.
- D. Protect piping from freezing conditions during the various stages of construction.
- E. Protect piping and valves from damage pending performance of systems tests.
- F. Protect installed thermometers and gauges from accidental damage by construction activity.

3.4 LOCATION OF EQUIPMENT:

- A. The mechanical sheets of the Contract Drawings are diagrammatical and not intended for use in determining the exact locations of the components of mechanical and electric systems.
- B. Equipment final locations will be determined by the equipment finally approved for installation. Final location of equipment will be determined by tube removal spaces, access and clearances required. Final layout shall be submitted for approval.
- C. Do all cutting and patching required for the installation of plumbing piping and equipment. Refer to Section 024119 for specific requirements.

3.5 CLEANING OF SYSTEMS

- A. After satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers and other accessory items, thoroughly clean all systems. Remove all burrs, cuttings and waste. Blow and flush piping until interiors are free of foreign matter.

Remove mill oil from steel piping by flushing with a mixture of detergent and non-foaming agent.

- B. Clean all strainers and dirt pockets prior to test, after tests and as often thereafter as necessary to guarantee no system stoppage, either whole or partial, by end of guarantee period.
- C. Should any system be stopped with refuse, which entered the system during construction is discovered after acceptance, pay for all labor and materials required to locate and remove the obstruction and replace and repair all work in any way disturbed.
- D. Remove all rust and thoroughly clean all surfaces to be insulated or painted.
- E. Sterilizing: Before placing in service, thoroughly flush all domestic Hot water and hot water recirculating piping. Sterilize as described in the Baltimore City Plumbing Code as modified in Section 221119. Where project phasing makes sterilization unpractical, flush the piping thoroughly and take water samples. Have the samples tested by an independent testing agency for compliance with Baltimore City Health Department standards. Repeat process until compliance is achieved. Submit copy of test results to the Architect.
- F. Leave all systems in clean, perfect condition and in complete running order.

3.6 ACCESS PANELS

- A. Refer to Architectural drawings and specifications for access panel locations, sizes and types.

3.7 FIELD INSTRUCTION

- A. Upon completion of work, furnish services of a competent representative to instruct Owner's representative in the proper operation and maintenance of all elements of the plumbing systems. Instructor must be approved by Architect.
- B. Spend not less than one four-hour day in such formal instruction and if necessary, to fully prepare the owner to operate and maintain the systems, such additional time as may be directed by the Architect.
- C. The specified day of instruction shall occur after thirty days operation by the Owner's representative.

3.8 EXCAVATION AND BACKFILL

- A. Do all excavating and backfilling necessary to install all underground mechanical work.
- B. Support and protect all pipes, ducts, cables or structures when such obstructions are uncovered. Repair all damage at contractor's expense.
- C. Establish all required lines and grades; be responsible for correctness thereof. Check elevation of sewers before starting.
- D. Excavate trenches to widths specified herein and to leave vertical sides. Where, under special circumstance, trenches with sloping sides are permitted, slope only to a plane one foot above top of pipe. From this plane to bottom of trench, make sides of trench vertical. Grade bottom of trenches accurately to provide uniform bearing and support on undisturbed earth along entire length of each section of pipe. Where pipe is not encased in concrete, support bottom quadrant fully and uniformly on a firm foundation; finish trench bottom by hand, shaping

- a groove from the barrel and scooping out hub holes. In lieu of hand shaping, or where rock excavation is required, excavate mechanically 3 to 4 inches below invert of line. Backfill overdepth with firmly compacted sand or fine gravel and then embed lower quadrant of pipe and shape hub holes as specified above. Except as specified herein, take care not to excavate below minimum required depths. Backfill unauthorized overdepths as specified for rock excavation. Where concrete encasement is specified, leave bottom of trench clean, smooth and flat. In all cases wherever wet or otherwise unstable soil, as determined by the Architect, is encountered excavate to such increased depth as may be directed. Then backfill to required level and form with firmly compacted sand or fine gravel.
- E. From a plane one foot above top of pipe to bottom of trench, make trench width at least 6 inches, but in no case more than 12 inches, wider on each side of pipe than the greatest external pipe diameter measured over the hubs. Where sheeting or shoring is used, measure minimum width between closest interior faces of sheeting or shoring as driven.
 - F. Unless otherwise indicated or directed excavate trenches to depth sufficient to give 36 inch minimum cover.
 - G. Make excavations for manholes, tanks and similar structures sufficiently large to leave at least 12 inches clear between their outer surfaces and the embankment or sheeting, if sheeting is used. Backfill any overdepth excavation with firmly compacted sand or fine gravel.
 - H. Keep excavated areas free of water. Do such grading as may be necessary to prevent surface water from flowing into trenches or other excavations; remove all water accumulating therein by pumping, bailing or other approved method.
 - I. Provide all sheeting, shoring and bracing necessary for protection of work and safety of personnel and compliance with the latest OSHA and MOSHA Regulations. Bracing shall be of approved size and quality.
 - J. Remove all excavated materials not required or not suitable for backfill.
 - K. Provide guard rails, lamps, flags or other safeguards as directed and adequate temporary crossovers for pedestrian and vehicular traffic. Remove when necessity for such protection ceases.
 - L. Protect trees by means of boxing, guying or other methods. Sustain in place and protect from direct or indirect injury any and all property and structures. Take care to prevent debris or other materials from entering existing sewers and drains. Carry on work so as not to interfere with their function.
 - M. Backfilling: As soon as pipe is laid, carefully place enough backfill on both sides of pipe to resist lateral movement. After joints have set, all required piping tests made, all water and debris removed from trenches, manually place backfill in 6" maximum depth layers up to a level of one foot over top of pipe. Exercise particular care to backfill simultaneously on both sides of pipes. Deposit all material up to a level of one foot over top of pipe with hand shovels. Compact each layer solidly before next layer is placed. Where pipe is specially coated for corrosion protection, take particular care not to damage coating. Deposit balance of backfill in one foot layers, thoroughly compacting each layer as it is placed. Backfill material shall consist of clean earth, loam, sandy clay, sand and gravel. Do not use frozen earth, large clods of earth or stone over 2-1/2" maximum dimension, organic material, debris, or cinders or other corrosive material.

- N. Where excavations are made in cinder fill, remove all excavated material and do not reuse. Make excavations wide enough and deep enough to permit placing a minimum of 10 inches of sand on all sides of pipe. Place and compact as specified above. Above the top 10 inches of sand, backfill with material and in manner specified above. No cinders may be used. At Contractor's option sand may be used for all backfill purposes unless specifically indicated otherwise.
- O. Settling: When backfilling is completed there shall be no settling. If any settling should occur, the Contractor shall correct it at no expense to the Owner.
- P. Restoring: Replace existing pavement, curbs, sidewalks, fences, sodding, shrubs, other appurtenances removed or damaged in connection with work. Restore to original condition. Sod must be replaced with sod. Any trees which are damaged shall be replaced by the Contractor with trees of similar type and size. For work in public streets, comply with municipal agencies' requirements or make necessary arrangement with such agency to make the repairs. Pay for all permits, inspection fees and cost of work so there will be no extra cost to Owner.

3.9 CUTTING AND PATCHING

- A. Do all cutting and patching necessary to install plumbing work.
- B. The cutting of walls, floors, partitions, slabs and decks for the passage and/or accommodation of piping and equipment, the closing of superfluous openings and the removal of all debris caused by said work under this contract shall be performed by the Contractor.

END OF SECTION 220500

SECTION 220523 – GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Check Valves.
- B. Ball valves.
- C. Drain valves.

1.2 RELATED WORK

- A. Section 220553 - Identification for Plumbing Piping and Equipment
- B. Section 220700 - Plumbing Piping Insulation
- C. Section 221116 - Domestic Water Piping

1.3 SUBMITTALS

- A. Submit copies of valve ordering schedule for approval before ordering valves.
- B. Submit detailed shop drawings under provisions of Section 013300. Clearly indicate make, model, location, type, size and pressure rating.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide valves of same manufacturer throughout where possible, Jenkins, Milwaukee, Stockham, Nibco or Apollo.
- B. Provide valves with manufacturer's name and pressure rating clearly and permanently marked on outside of body at the factory.

2.2 VALVE CONNECTIONS

- A. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.
- B. Thread pipe sizes 2 inches and smaller.
- C. Solder or screw to solder adaptors for copper tubing.

2.3 CHECK VALVES

- A. Bronze, y-pattern, horizontal swing disc, TFE or bronze seat disc, solder or screwed ends, 150 lb. steam, 300 psi W.O.G., Nibco Fig T-433-Y.

2.4 BALL VALVES

- A. Sizes 2-1/2" and smaller, Bronze body, 400 lb. C.W.P., 316 stainless steel ball and stem, multifill teflon seats and packing; soldered ends, three piece body, Apollo 82LF-200 series.
- B. Provide lever handle with stop pin for shut off service and memory stop for balancing service.

2.5 DRAIN VALVES

- A. Bronze ball valve with cap and hose thread, minimum 3/4" for lines up to 2-1/2", 1-1/2" for lines 3" and over, Apollo 70-200-HC Series bronze ball valve with dust cover and chain.

2.6 PRESSURE RATINGS

- A. Unless otherwise indicated, use valves suitable for 125 minimum psig WSP and 450 degrees F.

2.7 VALVE OPERATORS

- A. Where piping is insulated, provide valve operator extensions to suit insulation thickness. Coordinate with Section 220700 – Plumbing Piping Insulation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide valves at all branch connections to mains and at each piece of equipment to allow for isolation and service.
- B. Install valves with stems upright or horizontal, not inverted.
- C. Provide ball valves for shut-off and isolating service in domestic water piping.
- D. Provide drain valves at main shut-off valves, and low points of piping and apparatus and where required to permit draining of system.
- E. Provide operator stem extensions to suit insulation thickness, coordinate with insulation specifications and trade.

END OF SECTION 220523

SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Piping and equipment hangers, supports, and associated anchors.
- B. Sleeves and seals.

1.2 RELATED WORK

- A. Section 220700 – Plumbing Piping Insulation

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 013300.
- B. Indicate hanger and support framing and attachment methods.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sized ½ to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring, Grinnell figures 67, 69, 97, 104, 108, CT-109, CT-69.
- B. Hangers for Pipe Sizes 2 to 6 Inches: Carbon steel, adjustable, clevis, Grinnell figures 138, CT-65, 260, 300 or 590.
- C. Multiple or Trapeze Hangers: FRP channels with welded spacers and hanger rods.
- D. Uninsulated Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- E. Shield for Insulated Piping 2 Inches and Smaller: 18 gauge galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support.

2.2 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.3 CONCRETE INSERTS

- A. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 SLEEVES

- A. Sleeves through walls and floor: Form with 18 gauge type 316 stainless steel.

- B. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL listed.
- C. Fire Stopping Insulation: Glass fiber type, non-combustible.
- D. Caulk: UL listed fire stop sealant, 3M fire barrier CP 25WB, CP25N/S or CP255/L as required for sealing penetrations, floors and fire rated walls.

2.5 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation of supported pipe.
- B. Design hangers to allow for adjustment without disengagement of supported pipe.
- C. Provide copper plated hangers and supports for copper piping.

2.6 FIRE STOP SYSTEMS AND SEALANTS

- A. Refer to Architectural Division 07 - Thermal and Moisture Protection for sealing and fire stopping of plumbing penetrations through walls, floors, roofs or any other barrier.

PART 3 EXECUTION

3.1 CONCRETE INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- B. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.
- C. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

<u>PIPE SIZE</u>	<u>MAX. HANGER SPACING</u>	<u>HANGER DIAMETER</u>
½ to 1-1/4 inch	6'-0"	3/8"
1-1/2 to 2 inch	7'-0"	3/8"
2-1/2 to 3 inch	8'-0"	1/2"
4 to 6 inch	10'-0"	5/8"

- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.

- E. Support vertical piping at every floor.
- F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- G. Support riser piping independently of connected horizontal piping.
- H. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- I. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- J. Wherever possible, structural attachments shall be beam clamps, or rigid steel members embedded in poured concrete slabs, column, beams or walls.
- K. All rigid hangers shall provide a means of vertical adjustment after erection.
- L. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided.
- M. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- N. Supports, guides and anchors shall be so designed that excessive heat will not be transmitted to the building steel.
- O. Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

3.3 SLEEVES

- A. Set sleeves in position in form-work. Provide reinforcing around sleeves.
- B. Extend sleeves through floors one inch above finished floor level. Caulk inside of sleeves full depth and provide floor plate, caulked to make water tight.
- C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- D. Install chrome plated steel escutcheons at finished surfaces.
- E. Provide sleeves for all plumbing piping through all walls, floors and footings.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Identification of plumbing piping and equipment installed under Division 22.

1.2 REFERENCES

- A. ANSI A13.1 - Scheme for the Identification of Piping Systems

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 013300.
- B. Submit list of working, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Submit manufacturer's installation instructions under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Seton.
- B. A. B. C.
- C. Pittsburgh Paints.
- D. Marking Services, Inc.
- E. Substitutions: Approved equal under provisions of Section 012500.

2.2 MATERIALS

- A. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- D. Metal Tags: Brass or Aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

- E. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed. Seton "Setmark" or equal.
- F. Plastic Tape Pipe Markers: Flexible, vinyl form tape with pressure sensitive adhesive backing and printed markings.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.
- B. Plastic or Metal Tags: Install with corrosive-resistant chain.
- C. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.
- D. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instruction.

3.3 SCHEDULE

- A. Valves: Identify valves in main and branch piping with tags indicating service and area equipment served.
- B. Piping: Identify piping, concealed or exposed, with plastic pipe markers 2-1/2" and smaller and plastic tape pipe markers for 3" and larger. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure of enclosure, and at each obstruction.
- C. Identify equipment that is concealed above ceiling by attaching identification markers to the ceiling tile metal suspension system directly below piece of equipment.

END OF SECTION 220553

SECTION 220700 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED WORK

- A. Section 220529 - Hanger and Supports for Plumbing Piping and Equipment
- B. Section 220553 - Identification for Plumbing Piping and Equipment

1.3 REFERENCES

- A. ANSI/ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- B. ANSI/ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- C. ANSI/ASTM C547 - Mineral Fiber Preformed Pipe Insulation.
- D. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
- E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- F. ASTM E84 - Surface Burning Characteristics of Building Materials.
- G. NFPA 255 - Surface Burning Characteristics of Building Materials.
- H. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- I. UL723 - Surface Burning Characteristics of Building Materials.
- J. Factory Mutual Research Corporation - Simulated Pipe Chase Test.

1.4 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with three years minimum experience.
- B. Materials: Flame spread/fuel contributed/smoke developed rating of 25/50/50 in accordance with ASTM E84, latest revision. In addition, the product when tested will not melt or drip flaming particles, and the flame shall not be progressive. All materials shall pass simulated end-use fire tests.
- C. The materials shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity, and water vapor transmission (WVT).

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 013300.
- B. Include product description, list of materials and thickness for each service, and locations.
- C. Submit manufacturer's installation instructions under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Pittsburg-Corning.
- B. Johns Manville / Schuller.
- C. Knauf.
- D. Armacell.
- E. Certainteed.
- F. Dow.
- G. Substitutions: Under provisions of Sections 012500.

2.2 INSULATION

- A. Type A: Glass Fiber insulation; ANSI/ASTM C547; 'k' value of 0.24 at 75 degrees F; noncombustible.
- B. Type B: Cellular glass; ANSI/ASTM C552; maximum water vapor transmission rating of 0.2 perms; 'k' value of 27 at 75 degrees F.
- C. Type C: Hydrous calcium silicate; ANSI/ASTM C533; rigid white in preformed piping sections; asbestos free; 'k' value of 0.44 at 300 degrees F, suitable for 1200 degrees F operation.

2.3 JACKETS

- A. Interior Applications:
 - 1. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
 - 2. PVC Jackets: Service pipe sizes 2" and smaller, one piece, pre-molded type for fittings.

2.4 ACCESSORIES

- A. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.
- B. Finishing Cement: ASTM C449.
- C. Adhesives: Compatible with insulation, Armstrong 520, Benjamin Foster 85-75, Childers Chil-Seal CP-50A MV1 coating and adhesive or approved equal.

- D. Insulation Bands: 3/4 inches wide 0.020 inches thick ASTM B-209 aluminum.
- E. Metal Jacket Bands: 3/4 inches wide, 0.020 inches thick ASTM B-209 aluminum.
- F. Fibrous Glass Cloth: Untreated; 8 ounces per square yard weight.
- G. Cellular foam joint sealant: Pittsburgh Corning Pittseal 444.

PART 3 EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.
- B. Coordinate with other trades so that valve stems, operators, thermometer and control sensor wells, etc. are installed with proper mounting brackets and extensions are provided to allow insulation to run continuously and so that all penetrations can be sealed to protect the integrity of the vapor barrier.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions. Keep insulation dry and protected from damage.
- B. Continue insulation with vapor barrier through penetrations, sleeves and inside hangers. Stagger longitudinal joints on all insulation.
- C. In exposed piping, locate insulation and over seams in least visible location.
- D. On insulated piping with operating temperatures below 60 degrees or above 140 degrees, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. On insulated piping conveying fluids between 60 and 140 degrees F, do not insulate valves, flanges and unions at equipment, but bevel and seal ends of insulation at such locations with vapor barrier cement.
- F. Provide an insert, not less than 12 inches long, of same thickness and contour as adjoining insulation between support shield and piping, but under the finish jacket, on all piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be type B or Type C heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used.
- G. Neatly finish insulation at supports, protrusions, and interruptions.
- H. Jackets:
 - 1. Indoor, concealed and exposed applications: Insulated pipes with type A insulation shall have standard jackets with vapor barrier, factory-applied. Insulate fittings, joints and valves, with operating temperature above 140 degrees or below 60 degrees with insulation of like material and thickness as adjoining pipe, and finish with preformed PVC or aluminum fitting covers.
- I. Type A Insulation - Operating Temperature Below 60 Degrees:

1. Pipe Insulation: Insulate all piping in a neat, workmanlike fashion in accordance with thickness listed in schedule. Longitudinal laps of jackets shall be sealed and butt joints shall be wrapped with a 3" minimum wide strip of the jacketing material securely sealed in place. Adhesive to be Johns-Manville U-Glue, Epolux "Catalog" 400, Benjamin Foster 85-75, or approved equal.
2. Type B Insulation shall be applied in a single layer application with all joints tightly butted and sealed with joint sealant specified. Poorly fitting or broken insulation shall be replaced or re-cut to form a completely vapor sealed insulation system.
3. Fittings: Where the factory-premolded, one-piece PVC or two piece aluminum fitting covers are to be used, the proper factory precut insulation of like material and thickness as adjoining pipe, shall be applied to the fitting. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in fully. Insulating cover is then secured by stapling, tack fastening, banding or taping the ends to the adjacent pipe covering. All seam edges of the cover shall be sealed with vapor-barrier adhesive. The circumferential edges of cover shall be wrapped with vapor-barrier pressure sensitive color matching tape. The tape shall extend over the adjacent pipe insulation, and have an overlap on itself at least 2 inches on the downward side.

J. Type A Insulation - Operating Temperature Above 60 Degrees:

1. Pipe Insulation: Insulate all piping in a neat, workmanlike fashion in accordance with thicknesses listed in schedule. Jackets and butt strips.
2. Fittings: Where the factory-premolded one-piece PVC or two piece aluminum fitting covers are to be used, the proper factory precut insulation of like material and thickness as adjoining pipe shall be applied to the fitting. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. The fitting cover is then secured by stapling, tack fastening, banding or taping the ends of the adjacent pipe covering.

3.3 SCHEDULE

INSULATION PIPING	TYPE	PIPE SIZE INCH	THICKNESS INCH
Domestic Hot and Recirculating Water	A	1/2"	1/2"
		3/4"	3/4"
		1"	1"
Domestic Cold Water	A	1/2"	1/2"
		3/4"	1/2"
		1"	1/2"
		1-1/4"	1/2"
		1-1/2"	1"
		2"	1"

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe, fittings, and connections.

1.2 RELATED WORK

- A. Section 220523 - General Duty Valves for Plumbing Piping
- B. Section 220529 - Hanger and Supports for Plumbing Piping and Equipment
- C. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment

1.3 REFERENCES

- A. ANSI/ASME B16.3 - Malleable-Iron Threaded Fittings.
- B. ANSI/ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.
- F. ANSI/ASTM A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- G. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- H. ASTM A234 - Wrought Carbon Steel and Alloy Steel.
- I. ASTM A536 - Ductile Iron Castings.
- J. ANSI/AWS D1.1 - Structural Welding Code.
- K. ASTM B88 - Seamless Copper Water Tube.

PART 2 PRODUCTS

2.1 PIPE AND TUBE

- A. Copper Water Tube: ASTM B88, type, grade and temper as scheduled; seamless.

2.2 PIPE AND TUBE JOINTS AND FITTINGS

- A. Copper Pipe Fittings: ANSI/ASME B16.22 or B16.18, pressure fittings.

2.3 UNIONS AND COUPLINGS

- A. Pipe Size 2-1/2" Inches and Under: bronze, ground joint for copper or brass pipe, soldered ends.
- B. Pipe size over 2-1/2 inches: 150 psi forged steel slip-on flanges for ferrous piping.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe, or groove where allowed.
- B. Remove scale and dirt, inside and outside, before assembly.
- C. Remove welding slag or foreign material from pipe and fitting materials.
- D. Cut all pipes accurately to measurements established at structure. Work into place without springing or forcing, properly clearing all windows, doors or other openings. Cut pipe and nipples evenly; cut threads clean, remove burrs, ream ends to full inside bore. Install to permit free expansion and contraction without causing misalignment of piping or any damage to either building or piping. Grade all piping to low points to permit complete drainage of system. At bottom of water risers and at all low points provide a 3/4" drain valve. Make all changes of direction with fittings except as otherwise noted. Make pipe connections to equipment in accordance with indicated sizes and details or as directed. Cap or plug all equipment and pipe line openings during installation to exclude dirt and foreign material.
- E. Provide unions at each piece of equipment, in bypasses around equipment and in long runs or piping to permit convenient disassembly for alteration or repairs. Unions must be accessible after building is completed. Mechanical pipe couplings may be used as unions where mechanical pipe couplings are allowed elsewhere in this specification.
- F. Provide test connections for thermometers and pressure gauges at each piece of equipment.
- G. Where changes in pipe sizes occur, use only reducing fittings. Use eccentric fittings where required to prevent pocketing of air and/or water.

3.2 COPPER PIPE CONNECTIONS

- A. Form hot soldered joints in copper, brass, or bronze fittings with non lead based solder. Solder shall be Worthington Silver Bearing Alloy Lead-Free (95%-Tin, 4.8%-Copper, 0.2%-Silver) or approved equal. Fittings shall be clean and deburred prior to making up joints.
- B. Make connections to equipment and branch mains with unions.

3.3 TESTS

- A. Test all piping and prove tight. Notify Architect when tests will take place and submit test results prior to covering or enclosing any piping. Before enclosing, test piping which will be concealed. Replace and re-test to Architect's satisfaction any pipe or fittings broken or damaged under test. Caulking or peening joints will not be permitted.

- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, thermostatic traps and elements, other parts which are not designed to stand pressures use in testing piping.
- C. Test as follows:
 - 1. Cold, hot domestic water 125 psig hydrostatic
- D. Hold indicated pressures constant without pumping for such period of time as directed by Architect. While under pressure, visually inspect each joint, weld or other connection to determine leakage.

3.4 SCHEDULE OF PIPE AND FITTINGS

A. COLD AND HOT WATER PIPING:

1. BELOW GROUND 2" AND UNDER:

Pipe	type "K" copper, soft temper for runs less than 50 ft.
Fittings	socket type, wrought copper
Couplings	socket type, wrought copper
Joints	brazed

2. ABOVE GROUND 2" AND UNDER:

Pipe	copper type "L" hard drawn
Fittings	sweat type, wrought copper
Couplings	sweat type, wrought copper
Unions	sweat type, wrought copper, ground joint
Joints	joints soldered per paragraph 3.2A

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Hydrants
- B. Vacuum Breakers.
- C. Backflow Preventers.
- D. Disinfection of Domestic Water System.
- E. Water Pressure Reducing Valve.
- F. Pressure Gauges.
- G. Expansion Tanks
- H. Mixing Valves.
- I. Thermometers.

1.2 RELATED WORK

- A. Section 220523 - General Duty Valves for Plumbing Piping
- B. Section 221119 - Domestic Water Piping
- C. Section 224000 - Plumbing Fixtures

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Sections 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Watts
- B. Zurn.
- C. Wade.
- D. Josam.
- E. Jay R. Smith.
- F. Precision Piping Products.

G. Trerice.

H. Substitutions: Under provisions of Section 012500.

2.2 HYDRANTS

- A. Exterior Wall Hydrant : Zurn Z1300. Encased, anti-siphon automatic draining wall hydrant for flush installation. Complete with non-freeze type integral backflow preventer, bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer, and combination ¾" female or 1" male straight IP inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.
- B. Interior Wall Hydrant : WattsSeries LFSC-8 : Lead free cast brass hose bibb, ¾" female NPT regular pattern with vacuum breaker.

2.3 VACUUM BREAKERS

- A. Hose connection vacuum breakers shall be Watts 8a or approved equal.

2.4 BACKFLOW PREVENTER REDUCED PRESSURE

- A. Watts Series LF009 or equal with two in-line, independent check valves with an intermediate relief valve, NPT body connections, ball type test cocks, and quarter turn-full port-resilient seated-bronze ball valve shutoffs. Unit shall have renewable seats. Unit shall be complete with strainer.
- B. Unit shall be tested and certified under the following standards for reduced pressure zone backflow preventers; A.S.S.E. Std. No. 1013, AWWA std. No. C 511-89, FCCHR of USC Manual, Section 10.
- C. Unit shall be suitable for pressure up to 172 psig and water temperature up to 180 degree F.

2.5 BACKFLOW PREVENTER

- A. Inline double check valve backflow preventer shall be Watts Series LF7 or equal.

2.6 DISINFECTION OF DOMESTIC WATER SYSTEM

- A. Provide services of water treatment agency regularly engaged for the purposes of cleaning and disinfecting the domestic water piping. Disinfection shall be as described in the International Plumbing Code latest adopted edition.

2.7 WATER PRESSURE REDUCING VALVE

- A. Water pressure reducing valve with integral strainer shall be installed in the water service pipe near its entrance to building. The water pressure reducing valve shall be constructed using lead free materials. The valve shall feature a lead free cast copper silicone alloy body suitable for water supply pressures up to 300 psi. Provision shall be made to permit the bypass flow of water back through the valve into the main when pressures, due to thermal expansion on the outlet side of the valve, exceed the pressure in the main supply. Approved valve shall be listed to ASSE 1003. Valve shall be a Watts Series LF25AUB-Z3.

2.8 PRESSURE GAUGES

- A. Bourdon tube type of phosphor bronze with cast aluminum case, 4-1/2" dial, white dial with black numbers, solid front, and 1/2% minimum accuracy of full range. Terice 500X/600B Series. Range approximately 50% more than maximum operating pressure.

2.9 EXPANSION TANK FOR POTABLE HOT WATER

- A. Provide a Watts Model DETA pre-charged steel thermal expansion tank with fixed butyl bladder for fresh potable hot water applications. The tank shall have a top NPT stainless steel system connection and a 0.301" – 32 charging valve connection (standard tire valve) to facilitate the on-site charging valve of the tank to meet system requirements. Tank shall be pre-charged with air pressure to minimum 60 psig. Contractor shall coordinate with fill and pressure relief valves for final charging pressure.

2.10 THERMOSTATIC MIXING VALVE

- A. Thermostatic mixing valve shall be installed on the hot water supply to fixtures. The valve shall be ASSE 1017, ASSE 1069 and ASSE 1070 listed. It shall have a lead free cast copper silicone alloy body. The valve shall be a Watts Series LFMMVM1 or approved equal.

2.11 MIXING HOSE STATION

- A. Hot and cold water mixing hose station with ball valves at cold water and hot water entry points; equipped with dial-type; bronze construction; wall mount. The station shall be a Strahman Washdown Equipment model M-159TG.

2.12 THERMOMETER

- A. Type 300 Series stainless steel stem 9-1/4" O.D., case and ring, double strength window glass, white finished dial with black and blue markings accuracy 1% of full scale, balanced aluminum pointer with black finish, adjustable angle, 5" dial, Terice Series B85600, range 0 degrees to 250 degrees for hot water.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment per manufacturer's recommendations.
- B. Install vacuum breakers on plumbing lines where contamination of domestic water may occur and on hose bibbs, flush valves, etc.
- C. Furnish and install reduced pressure backflow preventers on the following services :
 - 1. Domestic water service
- D. Furnish and install funnel and drain assemblies on the backflow preventers and pipe them to the outdoors to prevent water from spraying around space.
- E. Provide pressure gauge at water service after pressure reducing valve. Provide thermometers at water heater.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe, fittings, and connections.

1.2 RELATED WORK

- A. Section 220523 - General Duty Valves for Plumbing Piping
- B. Section 220529 - Hanger and Supports for Plumbing Piping and Equipment

1.3 REFERENCES

- A. ASTM D2722 Polyvinyl Chloride (PVC) Schedule 40 Drainage Pipe

PART 2 PRODUCTS

2.1 PIPE AND TUBE

- A. Cast Iron Soil Pipe: ANSI/ASTM A74; service weight or extra heavy.
- B. Hubless Cast Iron Soil Pipe: CISPI 301.

2.2 PIPE AND TUBE JOINTS AND FITTINGS

- A. Cast Iron Pipe Fittings: ASTM C564, rubber gasket joints.
- B. Cast Iron Pipe Fittings: ASTM A74, long radius, no-hub joints.

2.3 UNIONS AND COUPLINGS

- A. CISPI, no-hub approved neoprene sleeve with stainless steel outer jacket and draw bands. Husky brand or equal, minimum four bands per coupling.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe, or groove where allowed.
- B. Remove scale and dirt, inside and outside, before assembly.
- C. Remove welding slag or foreign material from pipe and fitting materials.
- D. Cut all pipes accurately to measurements established at structure. Work into place without springing or forcing, properly clearing all windows, doors or other openings. Cut pipe and nipples evenly; cut threads clean, remove burrs, ream ends to full inside bore. Install to

permit free expansion and contraction without causing misalignment of piping or any damage to either building or piping. Grade all piping to low points to permit complete drainage of system. At bottom of water risers and at all low points provide a 3/4" drain valve. Make all changes of direction with fittings except as otherwise noted. Make pipe connections to equipment in accordance with indicated sizes and details or as directed. Cap or plug all equipment and pipe line openings during installation to exclude dirt and foreign material.

3.2 CAST IRON PIPE CONNECTIONS

- A. Joints for plain end pipe: neoprene gasket and stainless steel clamp.

3.3 TESTS

- A. Test all piping and prove tight. Notify Architect when tests will take place and submit test results prior to covering or enclosing any piping. Before enclosing, test piping which will be concealed. Replace and re-test to Architect's satisfaction any pipe or fittings broken or damaged under test. Caulking or peening joints will not be permitted.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, thermostatic traps and elements, other parts which are not designed to stand pressures use in testing piping.
- C. Test as follows:
 - 1. Flow and vent Standing Water Test
- D. Standing Water Test: Apply to drainage system in its entirety or in sections. If applied to entire system, close all openings in piping except highest opening; fill system with water to point of overflow. If system is tested in sections, close all openings except highest opening in section under test; fill each section with water. Test no section with less than 10 ft. head of water. In testing successive sections, retest at least the upper 10 feet of next preceding section so that no joint or pipe in building (except upper-most 10 ft. of system) shall have been submitted to a test of less than 10 ft. head of water. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts. During this period, add no additional water.
- E. Hold indicated pressures constant without pumping for such period of time as directed by Architect. While under pressure, visually inspect each joint, weld or other connection to determine leakage.

3.4 SCHEDULE OF PIPE AND FITTINGS

- A. SANITARY SYSTEMS:
 - 1. SANITARY PIPING – BELOW GRADE
 - a. Pipe Extra heavy cast iron
 - b. Fittings extra heavy cast iron
 - c. Joints "Push On"
 - 2. SANITARY PIPING – ABOVEGROUND (**)
 - a. Pipe Service weight cast iron
 - b. Fittings Service weight, long radius, cast iron
 - c. Couplings No-Hub
 - d. Joints No-Hub
 - 3. VENT PIPING (**)

- | | |
|--------------|--------------------------|
| a. Pipe | Service weight cast iron |
| b. Fittings | Service weight cast iron |
| c. Couplings | No-Hub |
| d. Joints | No-Hub |

(**) Note – At Contractor's option, and where permitted by code, schedule 40 PVC DWV may be used. Contractor is responsible for maintaining the integrity of smoke partitions and slabs as required by code.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Cleanouts.
- B. Floor Drains.
- C. Floor Sinks.
- D. Trench Drains.
- E. Solids Interceptor.

1.2 RELATED WORK

- A. Section 221316 - Sanitary Waste and Vent Piping

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Sections 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Drain, Backwater Valves, Cleanouts
 - 1. Zurn.
 - 2. Josam.
 - 3. Wade.
 - 4. Jay R. Smith.
 - 5. Substitutions: Under provisions of Section 012500.

2.2 CLEANOUTS AND CLEANOUT ACCESS COVERS

- A. Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate cleanouts on vertical rainwater leaders only. Ensure ample clearance at cleanout for rodding of drainage system.
- B. Cleanout Access Covers: In Unfinished Areas provide round covers with nickel bronze scored frames and plates. Provide round access covers in finished areas with depressed center section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

C. Cleanouts in horizontal surfaces shall be equal to the following Zurn models:

1. Unfinished Areas

a. All ZN-1400-NH

D. Cleanout covers for all vertical surfaces shall be Zurn ZN-1446.

2.3 FLOOR DRAINS

A. Floor drains shall be Zurn ZN-415B, lacquered cast iron body with bottom outlet, combination invertible membrane clamp and adjustable Type B nickel bronze strainer.

B. Provide lacquered cast iron deep seal "P" trap, spigot inlet and side outlet spigot connection.

2.4 FLOOR SINKS

A. 12" x 12" x 8" deep cast iron body and square, light-duty grate with 1/2" slotted openings, white acid resisting porcelain enamel interior and top, complete with seepage pan clamping collar and white ABS anti-splash interior bottom dome strainer. Zurn ZN-1901-KC.

2.5 TRENCH DRAINS

A. Channels shall be cut to length indicated on drawings with 12" wide reveal and have a 9-1/4" throat. Modular channel sections shall be made of 0% water absorbent High Density Polyethylene (HDPE). Channel shall mechanically lock into the concrete surround every 12". Channels shall weigh less than 5.05 lbs. per linear foot, have a smooth, 3" radiused self cleaning bottom. Channels shall have rebar clips standard to secure trench in its final location. Provided with fiberglass grate. Grate supplied in 24" nominal lengths with 13/16" wide slots. Provide Zurn Z882 or approved equal.

2.6 SOLIDS INTERCEPTOR

A. Josam 61300 Series epoxy-coated steel solids interceptor, installed below grade in vaulted enclosure, with no-hub connections, gasketed cover and removable solids collection basket.

PART 3 EXECUTION

3.1 INSTALLATION

A. Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover, remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joint.

B. Slope drainage lines 1/4 inch per foot where possible, 1/8 inch per foot minimum.

END OF SECTION 221319

SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Electric Domestic Water Heater

1.2 RELATED WORK

- A. Section 22 05 23 - General Duty Valves for Plumbing Piping
- B. Section 22 11 19 - Domestic Water Piping

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Sections 01 33 00.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Water Heater
 - 1. A.O. Smith
 - 2. Bradford-White
 - 3. State
 - 4. Rheem/Ruud.
 - 5. Substitution: Under provisions of Section 01 25 00.

2.2 DOMESTIC WATER HEATER

- A. The water heater shall be Dura-Power model as manufactured by A.O. Smith or an approved equal. Models shall meet the standby loss requirements of the U.S. Department of Energy and current edition of ASHRAE/IES 90.1. Heater shall be rated at capacity and size listed on drawings. Heater shall have 150 psi working pressure and be equipped with extruded high density anode rod. All internal surfaces of the heater exposed to water shall be glasslined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400 degrees F to 1600 degrees F. Electric heating elements shall be medium watt density with zinc plated copper sheath. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. The outer jacket shall be of backed enamel finish and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing. Heater shall include ASME T&P relief valve and drain valve.
- B. Heater tank shall have a three year limited warranty as outlined in the written warranty. Fully illustrated instructions manual shall be included.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment per manufacturer's recommendations.
- B. Provide drain pan under water heater. Refer to drawings.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Plumbing fixtures and trim.

1.2 RELATED WORK

- A. Section 220523 - General-Duty Valves for Plumbing Piping.
- B. Section 221116 - Domestic Water Piping.
- C. Section 221316 - Sanitary Waste and Vent Piping.

1.3 REFERENCES

- A. ADA - Americans with Disabilities Act of 1992.
- B. NSF - Standard 61, Section 9 for Drinking Water Faucets.

1.4 SUBMITTALS

- A. Submit manufacturer's product data and installation instructions under provisions of Section 013300.
- B. Submit proof of NSF Standard 61, Section 9 compliance and/or the International and UL listing.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

- A. Stainless Steel Sinks
 - 1. Elkay
 - 2. Griffin
 - 3. Just
- B. Trim
 - 1. Chicago
 - 2. T&S Brass
 - 3. American Standard
 - 4. Toto

5. Kohler

- C. Substitutions: Under provisions of Section 012500.

2.2 GENERAL

- A. Provide new fixtures, free from flaws and blemishes with finished surfaces clear, smooth and bright.
- B. Provide approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated. Fittings shall be listed by NSF and UL for drinking water.
- C. Fixtures shall be product of one manufacturer. Fittings of same type shall be product of one manufacturer.
- D. Protect fixtures against use and damage during construction.
- E. Handicapped accessible fixtures shall be installed in accordance with all requirements of the Americans with Disabilities Act (ADA) of 1992.

2.3 P-1 TWO COMPARTMENT SINK

- A. Two compartment sink with 18"x18"x12" deep bowls, 10" high back splash, 24" right side drainboard and stainless steel legs, 16 gauge type 300 series stainless steel, Elkay Model #2C18X18-R-24X. Provide Elkay Model #LK25RT, 3-1/2" drain fitting with 2" OD tailpiece, rotary lever operated, polished stainless steel.
- B. Faucet: Chicago Faucets No. 510-GVB613L12XKCAB, pre-rinse fitting with L-shaped swing type faucet, wall mounted with adjustable arms for 8" centers. Chrome plated. Water conserving pre-rinse spray valve, 1.0 GPM at 60 psi. 2-3/8" metal, vandal-proof, lever handles with sixteen-point, tapered broach and secured blue and red index buttons. Ceramic quarter-turn cartridge with integrated check valve, features square, tapered stem. 3/8" offset inlet supply arm with 1/2" NPT female thread inlet. 2-5/16" diameter slip flange. 23" riser with spring guide. 44" flexible stainless steel hose with insulated handle. Pipe strap and hook assembly.
- C. Supply Pipes: Flexible braided stainless steel supply tubes, Brass Craft loose key stop valves with double seal Model STR 15, cast brass escutcheon and set screw.

PART 3 EXECUTION

3.1 INSPECTION

- A. Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.2 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning. At completion, thoroughly clean plumbing fixtures and equipment.
- B. Provide chrome plated rigid or flexible supplies to fixtures with screw driver stops, reducers, and escutcheons.

- C. Install wall mounted lavatories, urinals, and water closets with approved wall carriers, model to suit installation.
- D. Mount fixtures to the following heights above finished floor:
 - 1. Lavatory
 - Refer to Architectural elevations, and to meet the requirements of the ADA.
- E. Install hose and faucets and hose connections with vacuum breakers.

3.3 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with plumbing fixture schedule on drawings.
- B. Coordinate with electrical Division for electrical accessories.

END OF SECTION 224000

SECTION 225300 – HABITAT POND PLUMBING SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pump.
- B. Strainer Basket.
- C. Pipe, fittings, and connections.
- D. Ball Valves.

1.2 RELATED WORK

- A. Section 220529 - Hanger and Supports for Plumbing Piping and Equipment

1.3 REFERENCES

- A. ASTM D2722 Polyvinyl Chloride (PVC) Schedule 40 Drainage Pipe

PART 2 PRODUCTS

2.1 PIPE AND TUBE

- A. Polyvinylchloride Plastic Pipe: PVC, Schedule 40, DWV.

2.2 PIPE AND TUBE JOINTS AND FITTINGS

- A. Poly Vinyl Chloride (PVC) Pipe Fittings: ANSI/ASME B16.22 or B16.18, pressure fittings.

2.3 BALL VALVES

- A. Ball valves for habitat pond plumbing shall be PVC True Union type, EPDM seal. Valves shall be designed for a water working pressure of not less than 150 psi.

2.4 PUMP

- A. Wet rotor water feature pump with threaded (FNPT) discharge and suction connections. Rated for continuous duty. 26 ft. cord length. Little Giant FP Series Model FP2 or approved equal.

2.5 STRAINER BASKET

- A. PVC simplex basket strainer with EPDM O-rings and socket ends connections. Equipped with PVC basket with 3/16" perforations.

PART 3 EXECUTION

3.1 PREPARATION

- A. Form solvent joints in PVC pipe and fittings to ANSI/ASTM D2855.
- B. Ream ends of pipe to remove all burrs and rough edges prior to installing pipe. Remove all debris from piping prior to making up joints.

3.2 INSTALLATION (VALVES)

- A. Provide ball valves at locations indicated on drawings
- B. Install valves with stems upright or horizontal, not inverted.

3.3 TESTS

- A. Test all piping and prove tight. Notify Architect when tests will take place and submit test results prior to covering or enclosing any piping. Before enclosing, test piping which will be concealed. Replace and re-test to Architect's satisfaction any pipe or fittings broken or damaged under test. Caulking or peening joints will not be permitted.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, thermostatic traps and elements, other parts which are not designed to stand pressures use in testing piping.
- C. Test as follows:
 - 1. Pond recirculation piping 125 psig hydrostatic
 - 2. Pond drain 25 psig hydrostatic
- D. Hold indicated pressures constant without pumping for such period of time as directed by Architect. While under pressure, visually inspect each joint, weld or other connection to determine leakage.

3.4 SCHEDULE OF PIPE AND FITTINGS

- A. HABITAT POND SYSTEMS:
 - 1. POND RECIRCULATING PIPING
 - a. Pipe schedule 40 PVC
 - b. Fittings socket type schedule 40 PVC
 - c. Couplings socket type schedule 40 PVC
 - d. Joints solvent cemented
 - 2. POND DRAINAGE
 - a. Pipe schedule 40 PVC
 - b. Fittings socket type schedule 40 PVC
 - c. Couplings socket type schedule 40 PVC
 - d. Joints solvent cemented

END OF SECTION 221316

SECTION 227000 – ANIMAL WATERER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior Animal Waterer, one installed in each of the two outdoor yards adjacent to the main building.
- B. Interior Animal Waterer, one installed in each of the indoor animal cages.
- C. All plumbing and drainage connections.

1.2 WORK REQUIRED BUT SPECIFIED UNDER OTHER SECTIONS

- A. Division 23-Mechanical: Requirements for plumbing and piping systems.
- B. Division 26-Electrical: Requirements for electrical connections.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include data on all models specified, accessories, details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- B. Shop Drawings: Show details of fabrication and installation. Include plans, elevations, sections, details and attachments to other work. Provide templates for anchors and bolts anchored to permanent construction.

PART 2 PRODUCTS

2.1 MANUFACTURERS ANIMAL WATERERS

- A. Manufacturers: Subject to compliance with Division 01 requirements regarding substitutions, provide the following from the Nelson Manufacturing Company (888-844-6606):

- 1. Exterior Animal Waterer:

- a) Series 700 Automatic Waterers – 730-10WS
- b) One drinker in each outdoor habitat.

- 2. Interior Animal Waterer:

- a) Series 1200
- b) One drinker in each indoor stall.

- B. Anchorage Devices: Provide anchor bolts, nuts, washers, bolts, sleeves, cast-in plate, and other anchorage devices as required to fasten housing assemblies securely in place and to suit installation type indicated. Hot-dip galvanize anchorage components.
- C. Shut-off valves. One for each drinker located in the adjacent interior keeper work space.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Examine roughing-in for plumbing and piping systems to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Coordinate installation of waterers as indicated in drawings and instructions by manufacturer.
- B. Provide rough-ins for water supply, drainage, and electrical conditions.

3.3 INSTALLATION

- A. Attach waterers in a manner that complies with the requirements of the manufacturer.

3.4 TESTING AND ADJUSTMENTS

- A. Test all equipment for proper and smooth operation. Adjust for proper operation. Correct all problems or inconsistencies.

END OF SECTION 227000

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

- A. All Provisions of this Section 230500 shall apply to all Sections of Division 23.
- B. The work of Division 23 includes providing all labor, material and equipment required to produce the various systems complete and operating.
- C. All work under this Division shall be subject to all applicable requirements of the Project Manual.
- D. The commissioning responsibilities found elsewhere in this project manual are applicable to this section.

1.2 CONTRACTOR'S INSTALLATION DRAWINGS

- A. Submit under provisions of Section 013300 for Architect's review six copies of Contractor's coordination and installation drawings coordinating plumbing, HVAC, sprinklers and equipment layouts and equipment rooms, mechanical shafts or any crowded location where there is a possibility of conflict among trades.
- B. Only drawings bearing Architect's stamp shall be used for construction. Keep drawings on job at all times.

1.3 MATERIAL AND EQUIPMENT REQUIREMENTS

- A. ALL products used on the project must be Asbestos FREE. Note, imports from Canada can contain asbestos and may state it is asbestos free but if the ingredients are checked it may contain chrysotile or Canadian fibers which is not considered asbestos in Canada but is considered asbestos here in the United States. This can be found in mastics, flooring products, and sheetrock. The Contractor shall be required to be aware of the products their company, and their subcontractors supply for the project. Contractor's shall be required to prudently check material MSDS sheets. Key words to look for include: asbestos, Canadian fibers, and Chrysotile mineral fibers.
- B. No materials or equipment shall be used in the work until reviewed and accepted for such work by the Engineer. Prior to submission of shop drawings, and within the time specified in Section 013300, the Contractor shall submit to the Engineer, a complete list of materials and equipment which he intends to furnish, giving manufacturer and catalog numbers. Shop drawings will not be considered for review until the complete list of the manufacturers of all materials and equipment has been accepted.
- C. All materials and equipment shall be new and the best of their respective kinds, suitable for the conditions and duties imposed on them after installation. All applicable materials and equipment shall be such as found in the approved list of the National Board of Fire Underwriters. Where applicable, all materials and equipment used shall bear the label of the Underwriter's Laboratories, Inc. securely attached.

- D. All equipment shall be supplied to the job in sections which can readily pass through the openings provided. If necessary, sections shall be assembled and connected at the site, within the space which they occupy.
- E. Only those materials and equipment named in the specifications by giving the name of the manufacturer, or by brand or trade name or catalog reference, shall be used as a basis for the preparation of the base proposal, and only those materials shall be furnished under the Contract.
- F. Should the bidder desire to use any materials or products other than those specified by name, he shall submit the proposed substitution to the Engineer for review ten (10) days prior to the date of the proposal.
- G. Where substitutions are allowed herein, any equipment so accepted shall meet all specified requirements in all aspects of design, space requirements, electrical characteristics, power consumed, and suitability to system design. Any changes in wiring, controls, etc., from that shown on the contract drawings necessary to accommodate the equipment substituted shall be made by the Contractor at his expense. Where substitutions require change in the work under other sections, the Contractor shall make all such changes at his expense. Acceptance of the shop drawings of the substitution does not relieve the Contractor of this responsibility.
- H. Material list shall be submitted within thirty (30) days after award of contract.

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Section 013300.
- B. The Contractor shall submit shop drawings to the Engineer for review before fabrication of any equipment.
- C. Shop drawings, cuts, sheets, and other data shall bear the Contractor's stamp of approval as an indication that he has examined them and found thereon complete information as to the space requirements, electrical characteristics, power consumption, suitability to system design, and considers the material or equipment to fully meet the specifications.
- D. Review of shop drawings will be general and will not relieve the Contractor from the responsibility for quantities, for proper fitting and construction of the work, or from furnishing materials and work required by the contract which may not be indicated on the shop drawings when accepted.
- E. All materials and equipment shall be new, of best quality and grade, all subject to Architect's review. None shall be used until they have been reviewed. Use product of one manufacturer where two or more items of same kind of equipment are required. Reuse existing equipment only where specifically indicated.
- F. Submit under provisions of Section 013300 a list of proposed manufacturer's and suppliers of all items of mechanical equipment for the Architect's review. Submittals will not be processed until this list has been reviewed.

1.5 REGULATIONS AND PERMITS

- A. Perform all work in accordance with the applicable regulations of N.F.P.A., all State and Municipal building ordinances, codes and regulations and any insuring agency having jurisdiction.
- B. Furnish required certificates of approval. Obtain and pay for all required fees, permits and inspections.
- C. Within 30 days after award of Contract, make application for inspection service, simultaneously filing a copy of the application with the Architect as proof of having requested this service.

1.6 GUARANTEES

- A. Guarantee complete mechanical installation free of all defects of material, equipment and workmanship for one year beginning from date of final acceptance of work. During this year be responsible for proper adjustment of all systems, equipment and devices installed by Contractor and correct all defects or maladjustments promptly without additional expense to Owner. This shall not include normal maintenance, care and operation of the systems.
- B. Contractor's attention is directed to guarantee periods greater than one year on certain items of equipment. These requirements are spelled out in detail in the Articles covering the specific equipment.

1.7 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish manual containing a brief description of each system. Include explicit instructions for operating the systems. Provide under provisions of Section 017823.
- B. In addition furnish the following information in each manual:
 - 1. Manufacturer's printed operating and maintenance instructions, parts lists, illustrations and diagrams for each piece of equipment.
 - 2. A complete schedule of periodic servicing and lubrication requirements for all equipment.
 - 3. Manufacturer's data report form U-1 certifying Code compliance for each piece of equipment specified to be constructed in accordance with ASME Code for Unfired Pressure Vessels.
 - 4. One copy of each shop drawing and Contractor's record drawings, and record control diagrams.
 - 5. One copy of each wiring diagram.
 - 6. One copy of testing and balancing report.
 - 7. One copy of Valve chart.
- C. Place these instructions in Architect's hands at least 30 days prior to date system will be turned over to Owner.
- D. After review by Architect, revise as required, and supply copy to Owner and to Architect.

PART 2 PRODUCTS

2.1 ELECTRICALLY OPERATED EQUIPMENT AND CONTROLS

A. Unless otherwise indicated:

1. All starters, all disconnect switches and all work pertaining to equipment power connections are specified under Division 26, Electrical Work.
2. All control circuit wiring, including all electrical interlocking, relay wiring, remote controls and temperature controls shall be provided under Division 23, and shall be in conformance with the requirements of Division 26.
3. Provide all control devices suitable for operation on a maximum of 120 volt service.
4. Where applicable all equipment used shall bear the label of the Underwriter's Laboratories, Inc. securely attached.

2.2 MOTORS

- A. Motors for all equipment specified under this Section of the Specification shall be provided with the equipment.
- B. Unless specifically noted otherwise, all motors 1/2 HP and over shall be suitable for 480 volts, 3 phase, 60 hertz current, and those under 1/2 HP for 120 volts, single phase, 60 hertz current. All motors shall be equipped with grease-packed ball bearings.
- C. Fractional horsepower motors, 1/12 horsepower and larger, shall be permanently split capacitor or split phase. Shaded pole motors will only be acceptable for motors smaller than 1/12 horsepower.
- D. Where a motor supplied differs from the motor indicated for a certain piece of equipment, and the difference requires a change in starter, feeder, branch circuit or other electrical items, include the cost of such electrical changes under the Section of the Specifications wherein the particular piece of equipment is specified.
- E. Design motors in accordance with NEMA standards and affix to each a nameplate accurately listing all pertinent data. Each motor shall have sufficient capacity to start and operate the machine it drives without exceeding the motor nameplate rating at the speed specified or at any speed or load which may be obtained by the drive actually furnished. Except as noted, rate all motors for continuous duty at 100% of rated capacity. The NEMA standard service factor may be applied only to motors having water or refrigerant cooling. The indicated motor horsepower are those estimated to be required by the driven equipment when operating at specified duties and efficiencies and are to be used to determine electrical feeder sizes. If the actual horsepower required for the equipment proposed to be furnished is greater than the indicated horsepower, it shall be provided at no additional expense to the Owner; and equally, if it is less, no credit shall accrue to the Owner.
- F. Unless otherwise indicated, polyphase motors shall be NEMA Design B, general purpose, squirrel cage, single speed, open drip proof, induction type, with Class B Insulation, stamped with NEMA Design B letter designation. Motors 20 horsepower and above shall be high efficiency type, 92% efficiency minimum. Motors connected to variable frequency drives shall be inverter duty rated.
- G. Single phase motors, open, capacitor start type.

- H. Provide motors with adjustable V-belt drives with a cast iron or steel base, slide rail and adjustable screw device.
- I. V-Belt Drives: Sheave diameters shall not be less than the drive manufacturer's minimum recommended diameter for various belt cross-sections. Belt velocity must lie within the 2500 fpm to 4000 fpm range. The NEMA minimum sheave diameter is not acceptable.
- J. Alignment of motors and drives and placing motors and equipment on foundations ready for operation shall be included in the work of the Section wherein the particular equipment is specified.

PART 3 EXECUTION

3.1 WORKMANSHIP

- A. Install all materials and equipment in a neat and workmanlike manner. When directed, remove, replace, at Contractor's expense, all work not presenting an orderly, reasonable neat or workmanlike appearance or work failing to meet performance requirements.
- B. Coordinate all work and cooperate with other trades in building to facilitate proper and intelligent execution of work.

3.2 MANNER OF INSTALLATION

- C. Install all piping and ductwork to permit easy access to all valves, dampers, traps and other equipment requiring periodic servicing. Provide extension devices and remote operators as necessary for all valves, dampers and lubrication points which require frequent service, adjustment or control and which cannot be located in a readily accessible and safe place.
- D. Unless otherwise directed, or where existing piping or ductwork is exposed, or in mechanical rooms, conceal all piping and ductwork. In all cases, install piping and ductwork to follow lines of building and to allow maximum headroom consistent with proper pitch.

3.3 PROTECTION OF THE WORK:

- A. Cover openings in ductwork, conduits and piping and temporarily seal to protect from contamination.
- B. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water using raised platforms.
- C. Protect unfinished work at the end of each work day from damage contamination and moisture, by the use of plugs, caps, or covers.
- D. Protect piping from freezing conditions during the various stages of construction.
- E. Protect piping and valves from damage pending performance of systems tests.
- F. Protect installed thermometers and gauges from accidental damage by construction activity.

3.4 LOCATION OF EQUIPMENT:

- A. The mechanical sheets of the Contract Drawings are diagrammatical and not intended for use in determining the exact locations of the components of mechanical and electric systems.

- B. Equipment final locations will be determined by the equipment finally approved for installation. Final location of equipment will be determined by tube removal spaces, access and clearances required. Final layout shall be submitted for approval.
- C. Do all cutting and patching required for the installation or demolition of mechanical equipment. Refer to Section 024119 for specific requirements.

3.5 CLEANING OF SYSTEMS

- A. After satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers and other accessory items, thoroughly clean all systems. Remove all burrs, cuttings and waste. Blow and flush piping until interiors are free of foreign matter. Remove mill oil from steel piping by flushing with a mixture of detergent and non-foaming agent.
- B. Clean all strainers and dirt pockets prior to test, after tests and as often thereafter as necessary to guarantee no system stoppage, either whole or partial, by end of guarantee period.
- C. Clean all fans, ductwork, enclosures, flues, registers, grilles and diffusers of all rubbish and plaster at completion of work.
- D. Should any system be stopped with refuse, which entered the system during construction is discovered after acceptance, pay for all labor and materials required to locate and remove the obstruction and replace and repair all work in any way disturbed.
- E. Remove all rust and thoroughly clean all surfaces to be insulated or painted.
- F. Leave all systems in clean, perfect condition and in complete running order.

3.6 ACCESS PANELS

- A. Refer to Architectural drawings and specifications for access panel locations, sizes and types.

3.7 START UP AND TRIAL OPERATION

- A. Scope: Start up and put in trial operation all air handling systems, pumps, and related equipment as specified.
- B. Preparation: Before starting any equipment, completely assemble all systems, test for leaks or other defects, connect and test all safety devices, lubricate all bearings, charge refrigeration system with refrigerant and oil, adjust belts and drives, align motors and the equipment they drive, check rotation of all equipment and check that the correct thermal element is installed in each starter.
- C. Time Period: After the preparatory work specified above has been accomplished, start each system and put in trial operation for a minimum period of five 8 hour days.
- D. Corrections: Repair or replace any device which may prove defective during the trial operation period and re-run.
- E. Costs: Electrical energy for the tests will be provided by the Owner.

- F. Scheduling: Schedule trial operations in coordination with Adjusting and Balancing work. If permitted by the Architect more than one system may be operated at the same time. Submit schedule for Architect's review.
- G. Extension of Time: If, during the trial operation period, any part of a system is inoperative for any reason, extend the trial operation period by the amount of the downtime. Instruction time is in addition to trial operation time.

3.8 FIELD INSTRUCTION

- A. Upon completion of work, furnish services of a competent representative to instruct Owner's representative in the proper operation and maintenance of all elements of the mechanical systems. Instructor must be approved by Architect.
- B. Spend not less than two (2) four-hour days in such formal instruction and if necessary, to fully prepare the owner to operate and maintain the systems, such additional time as may be directed by the Architect.
- C. One of the specified days of instruction shall occur after thirty days operation by the Owner's representative.
- D. The specified two (2) days shall be in addition to time required for instruction purposes for automatic controls.
- E. Contractor shall provide video tapes of the operating instruction to the Owner.

3.9 CUTTING AND PATCHING

- A. Do all cutting and patching necessary to install mechanical work.
- B. The cutting of walls, floors, partitions, slabs and decks for the passage and/or accommodation of ductwork and equipment, the closing of superfluous openings and the removal of all debris caused by said work under this contract shall be performed by the Contractor.

END OF SECTION 230500

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe, duct, and equipment hangers, supports, and associated anchors.
- B. Equipment bases and supports.
- C. Sleeves and seals.

1.2 RELATED WORK

- A. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment
- B. Section 230719 - HVAC Piping Insulation

1.3 REFERENCES

- A. ANSI/ASME B31.1 - Power Piping.
- B. NFPA 101 - Life Safety Code.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 013300.
- B. Indicate hanger and support framing and attachment methods.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sized ½ to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring, Grinnell figures 67, 69, 97, 104, 108, CT-109, CT-69.
- B. Hangers for Pipe Sizes 2 to 6 Inches: Carbon steel, adjustable, clevis, Grinnell figures 138, CT-65, 260, 300 or 590.
- C. Hangers for pipe sizes 8" and over: carbon steel, adjustable roller type. Grinnell figures 171, 175, 177, 178, 271, 274 or 275.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook, Grinnell figure 126.
- F. Wall Support for Pipe Sizes to 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- G. Vertical Support: Steel riser clamp, Grinnell figures 261 or CT-121.

- H. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support, Grinnell figure 264.
- I. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- J. Shield for Insulated Piping 2 Inches and Smaller: 18 gauge galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support.
- K. Shield for Insulated Piping 2-1/2 Inches and Larger: Type 2 or 3 insulation insert between pipe and hanger pipe. Provide 18 gauge galvanized steel shield between hanger and insert, in 180 degree segment, 12" long.
- L. Shields for Vertical Copper Pipe Risers: Sheet Lead.
- M. Pipe alignment guides: Carbon steel, with one coat of primer paint for rust protection, complete with housing and spider assembly. Similar to Grinnell figure 256 or Advanced Thermal Systems Model HL or CL. Select guides suitable for 1200 degrees F for use on engine exhaust pipe, and provide thermal barrier equal to Advanced Thermal Systems Model CL for guides used on chilled water piping.

2.2 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded. Rods located outdoors or in Boiler Room shall be galvanized or chrome plated.

2.3 CONCRETE INSERTS

- A. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel.
- B. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL listed.
- C. Sleeves for Round or Rectangular Ductwork: Form with galvanized steel.
- D. Fire Stopping Insulation: Glass fiber type, non-combustible.
- E. Caulk: UL listed fire stop sealant, 3M fire barrier CP 25WB, CP25N/S or CP255/L as required for sealing penetrations, floors and fire rated walls.

2.5 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation of supported pipe.
- B. Design hangers to allow for adjustment without disengagement of supported pipe.
- C. Provide copper plated hangers and supports for copper piping.

- D. Provide galvanized supports for all supports and hangers located in the Mechanical Room or outdoors.

2.6 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

2.7 FIRE STOP SYSTEMS AND SEALANTS

- A. Refer to Architectural Division 07 - Thermal and Moisture Protection, for sealing and fire stopping of mechanical penetrations through walls, floors, roofs or any other barrier.

PART 3 EXECUTION

3.1 CONCRETE INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- B. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.
- C. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

<u>PIPE SIZE</u>	<u>MAX. HANGER SPACING</u>	<u>HANGER DIAMETER</u>
2 to 1-1/4 inch	6'-0"	3/8"
1-1/2 to 2 inch	7'-0"	3/8"
2-1/2 to 3 inch	8'-0"	2"
4 to 6 inch	10'-0"	5/8"

- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- G. Support riser piping independently of connected horizontal piping.

- H. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- I. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- J. Wherever possible, structural attachments shall be beam clamps, or rigid steel members embedded in poured concrete slabs, column, beams or walls.
- K. All rigid hangers shall provide a means of vertical adjustment after erection.
- L. Contractor shall coordinate with Section 230548, Vibration and Seismic Controls for HVAC Piping and Equipment, for hangers requiring vibration control.
- M. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided.
- N. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- O. Supports, guides and anchors shall be so designed that excessive heat will not be transmitted to the building steel.
- P. Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

3.3 SLEEVES

- A. Extend sleeves through floors one inch above finished floor level. Caulk inside of sleeves full depth and provide floor plate, caulked to make water tight.
- B. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- C. Install chrome plated steel escutcheons at finished surfaces.
- D. Provide sleeves for all piping and ductwork through all walls and floors.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Vibration isolation for piping, ductwork and equipment.
- B. Flexible hangers.

1.2 REFERENCES

- A. ASHRAE - Guide to Average Noise Criterial Curves.
- B. International Building Code 2003.
- C. NFPA 5000 - The Building Construction and Safety Code.
- D. NFPA 13 and 14 for Fire Protection Systems.
- E. Mason Industries Seismic Restraint Guidelines, Latest Edition.

1.3 QUALITY ASSURANCE

- A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 013300.
- B. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
- C. Submit manufacturer's installation instructions under provisions of Section 013300.
- D. Where walls, floors, slabs or supplementary steel work are used for seismic, restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers submittals must include spacing, static levels, and seismic loads at all attachment and support points.
- E. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

1.5 CERTIFICATES

- A. Submit manufacturer's certificate under provisions of Section 013300 that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

1.6 CODE AND STANDARD REQUIREMENTS - INTENT

- A. Provide seismic restraints to keep all mechanical building systems and components in place during a seismic event. All such systems must be installed in strict accordance with seismic codes, component manufacturer's, and building construction standards.
- B. Seismic restraints shall be designed in accordance with seismic force levels equal to or exceeding the requirements of IBC 2003 USE Group III, category C.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Mason.
- B. Vibration Mountings and Controls.
- C. Peabody.
- D. Vibration Eliminator.
- E. Vibro-Acoustics.
- F. Substitutions: Approved equal under provisions of Section 01600.

2.2 MOUNTINGS

- A. Type A: Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be type BR as manufactured by Mason Industries, Inc.
- B. Type B: Spring type isolation shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Mountings shall be type SLF as manufactured by Mason Industries, Inc.
- C. Type C: Restrained spring mountings shall have an SLF mounting as described in Type B, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Restraining Bolts shall have a neoprene bushing between the bolt and the housing. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall be type SLR or SLRS as manufactured by Mason Industries, Inc..

- D. Type P: Neoprene cross ribbed or waffle pattern, 5/16 inches thick. Provide 1/4 inch hot dipped galvanized steel bearing plates. Permanently identify durometer. Mason Industries, Inc. Type W.
- E. Type Q: Neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered to prevent corrosion and have friction pads, both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole with cap screw and washer on top. Mountings shall be type ND as manufactured by Mason Industries, Inc.

2.3 HANGERS

- A. Type D: Hangers shall consist of rigid steel frames containing minimum 1-1/4" (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in Type B seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30E arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30E capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc
- B. Type E: Hangers shall be as described in Type D, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30E capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
- C. Type F: Vibration hanger shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided to attach the housing to the flat iron duct straps. Submittals shall include a scale drawing of the hanger showing the 30 degree capability. Hangers shall be type W30 as manufactured by Mason Industries, Inc.

2.4 BASES

- A. Type G: Provide integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be 'T' or 'L' shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch. Bases shall be type WFSL as manufactured by Mason Industries, Inc.
- B. Type H: Provide steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base. Members shall be sufficiently rigid to prevent strains in the equipment. Inverted saddles shall be type ICS as manufactured by Mason Industries, Inc.

- C. Type J: Provide rectangular structural beam or channel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcement consisting of half-inch bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions. Forms shall be furnished with steel templates to hold the anchor-bolt sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Base shall be Type BMK or K as manufactured by Mason Industries, Inc.

2.5 PIPE CONNECTORS

- A. Type K: Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar® tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1-1/2" may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi up to 170EF with a uniform drop in allowable pressure to 215 psi at 250EF in sizes through 14". All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be type SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.
- B. Type L-1: Flexible bellows type bronze hose with bronze braid, sweat connections. Length: 8 times diameter, 10" minimum. Suitable for freon refrigerant service. Compressor discharge servicing working pressure 200 psi at 100 degrees F. Mason Industries, Inc. Type BBF.
- C. Type L-2: Flexible stainless steel type hose with 304 stainless steel braided hose, flanged, sweat or grooved connections. Provide hoses with a safety factor of 4, with one fixed and one floating raised face carbon steel plate flange. Sizes 2-1/2" and smaller may have threaded nipples. Copper sweat ends, 4" and smaller may have SS (gas service) or Bronze (water service) bodies. Grooved ends may be used in sizes 2" through 12" where grooved piping is allowed elsewhere in the specification. Welding is not acceptable. Minimum lengths, minimum live lengths, and minimum number of convolutions per foot to assure flexibility are as tabulated. Shorter lengths are not acceptable. Hoses shall be installed on the equipment side of the shut off valves horizontal and parallel to the equipment shafts wherever possible. Submittals shall include test data showing force/displacement, fittings, material, live lengths, number of corrugations per foot, and safety factor at pressure ratings. Hoses shall be Mason Industries, Inc. Type BSS or CPSB. Hoses suitable for refrigerant service, and compressor discharge service shall have a working pressure 200 psi at 100 degrees F.

Pipe or Tubing Size (in)	FLANGED		THREADED		GROOVED		COPPER SWEAT BRONZE		Min. Convoluti ons per (foot)
	Face to Face (in)	Live Length (in)	End to End (in)	Live Length (in)	End to End (in)	Live Length (in)	End to End (in)	Live Length (in)	
1/2	-	-	24	19-3/4	-	-	18	14-1/4	92
3/4	-	-	24	19-3/4	-	-	18	13-3/4	80
1	-	-	24	19-3/4	-	-	18	13-3/8	72
1-1/4	-	-	24	18-3/4	-	-	18	13-1/4	67
1-1/2	24	21-7/8	24	18-3/4	-	-	18	13	63
2	24	21-1/8	24	18	24	18	18	12-1/2	58
2-1/2	24	21-1/8	24	17	24	18	18	10-3/4	48
3	36	33-1/8	36	29	36	30	18	10-1/2	46
4	36	33-1/8	36	29	36	28	24	15-1/2	32
5	36	32-7/8	-	-	36	28	-	-	29
6	36	32-7/8	-	-	36	28	-	-	25
8	36	32-5/8	-	-	36	28	-	-	23
10	36	32-5/8	-	-	36	26	-	-	21
12	36	32-5/8	-	-	36	26	-	-	20
14	36	32-5/8	-	-	-	-	-	-	18
16	36	32-5/8	-	-	-	-	-	-	16

2.6 ACOUSTICAL SEALS

- A. Type M: Split Wall Seals consist of two bolted pipe halves with minimum 3/4" (19mm) thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240EF, 10# density fiberglass may be used in lieu of the sponge. Seals shall be type SWS as manufactured by Mason Industries, Inc. .

2.7 PIPE ANCHORS

- A. Type N: All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Unless otherwise noted on the equipment schedule, all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonable uniform deflection. Deflections shall be as noted in the schedule.
- B. The first four pipe hangers in the main lines near isolated mechanical equipment shall be supported with hangers as described in the Type E. Horizontal runs in all other locations in mechanical rooms and equipment rooms shall be isolated by hangers as described in Type D. Floor supported piping shall rest on isolators as described in Type C. Heat exchangers shall be considered part of the piping run. All Type E hangers or the first three Type C mounts as noted above, will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1.5" deflection for pipe sizes up to and including 6", and 2.5" deflection thereafter. All other hangers and mounts will have a minimum steel spring deflection of 0.75". Hangers shall be located as close to the overhead supports as practical.
- C. All piping passing through boiler or equipment room walls, floors, or ceilings, shall be protected against sound leakage by means of an acoustical wall seal as described in Type M.
- D. Piping risers shall be suspended from or supported by Type E hangers or Type C mountings and the piping anchored or guided with Type N anchors. Steel spring deflections shall be minimum of 0.75" except in those expansion locations where additional deflection is required to limit deflection or load changes to plus or minus 25% of the initial stress.
- E. All duct discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of Type D hangers or Type B floor supports. Spring deflections shall be a minimum of 0.75".

3.2 SCHEDULE

<u>ISOLATION EQUIPMENT</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFL.(IN)</u>
Inline EF	All	D	0.75"
Unit Heater	Mezzanine	D	0.75"

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Identification of mechanical products installed under Division 23.

1.2 REFERENCES

- A. ANSI A13.1 - Scheme for the Identification of Piping Systems

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 013300.
- B. Submit list of working, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Submit manufacturer's installation instructions under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Seton.
- B. A. B. C.
- C. Pittsburgh Paints.
- D. Marking Services, Inc.
- E. Substitutions: Approved equal under provisions of Section 012500.

2.2 MATERIALS

- A. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- D. Metal Tags: Brass or Aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- E. Stencils: With clean cut symbols and letters of following size:

SERVICE

SIZE OF LETTERS

Ductwork and Equipment

2-1/2"

- F. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed. Seton "Setmark" or equal.
- G. Plastic Tape Pipe Markers: Flexible, vinyl form tape with pressure sensitive adhesive backing and printed markings.
- H. Duct System Markers: Use Seton Style 85266 markers for dampers and all other components. Minimum 7-1/2"W X 4-1/2"H, Custom Self Adhesive Vinyl, indicate air flow type, direction, and air handling unit or fan number.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.
- B. Plastic or Metal Tags: Install with corrosive-resistant chain.
- C. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.
- D. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instruction.

3.3 SCHEDULE

- A. Equipment: Identify equipment, pumps, and heat transfer equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- B. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- C. Valves: Identify valves in main and branch piping with tags indicating service and area or equipment served.
- D. Piping: Identify piping, concealed or exposed, with plastic pipe markers 2-1/2" and smaller and plastic tape pipe markers for 3" and larger. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure of enclosure, and at each obstruction.
- E. Identify equipment that is concealed above ceiling by attaching identification markers to the ceiling tile metal suspension system directly below piece of equipment.
- F. Ductwork: Identify ductwork with stenciled painting or duct system markers. Identify as to air

flow type, direction, and air handling unit or fan number. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum of one marker for every 25 feet in straight duct runs.

- G. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.
- H. Duct System Markers: Use Seton Style 85266 markers for dampers and all other components. Minimum 7-1/2"W X 4-1/2"H, Custom Self Adhesive Vinyl.

END OF SECTION 230553

SECTION 230593 – TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Testing, adjusting and balancing of air and water systems.
- B. Preparation of interim and final reports.

1.2 REFERENCES

- A. The commissioning responsibilities stated elsewhere in this Project Manual are applicable to this section.

1.3 SUBMITTALS

- A. Submit name and resume' of proposed balancing contractor.
- B. Submit Interim and Final Reports as herein described.

1.4 QUALIFICATION

- A. The testing and balancing agency shall be an independent organization specializing in this type of work. The organization shall be a member of the Associated Air Balance Council and shall present evidence of having satisfactorily performed work of similar size and complexity for a minimum period of two years.

PART 2 PRODUCTS

2.1 PERSONNEL AND INSTRUMENTS

- A. Perform all work with properly trained personnel using accurately calibrated instruments. All instruments shall have been calibrated within the six months immediately preceding the commencement of work.

PART 3 EXECUTION

3.1 SCHEDULING

- A. Schedule trial operations in coordination with Adjusting and Balancing work. If permitted by the Engineer more than one system may be operated at the same time. Submit schedule for Engineer's review.

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper T&B of systems and equipment.

- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine equipment performance data including fan and pump curves.
- E. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean permanent filters are installed, and controls are ready for operation.
- F. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected, configured by the controls contractor and functioning.
- G. Examine strainers to verify that mechanical contractor has replaced startup screens with permanent screens and that all strainers have been cleaned.
- H. Examine two-way valves for proper installation and function.
- I. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- K. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.

3.3 PREPARATION

- A. Prepare a T&B plan that includes:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Prepare system-readiness checklists, as described in the AABC National Standards for Total System Balance, for use by contractors in verifying system readiness for T&B. These shall include, at a minimum:
 - 1. Airside:
 - a. All ductwork is complete with all terminals installed.
 - b. All volume, smoke and fire dampers are open and functional.
 - c. Clean filters are installed.
 - d. All fans are operating, free of vibration, and rotating in correct direction.

- e. VFD start-up is complete and all safeties are verified.
- f. Automatic temperature-control systems are operational.
- g. Ceilings are installed.
- h. Windows and doors are installed.
- i. Suitable access to balancing devices and equipment is provided

2. Hydronics

- a. Piping is complete with all terminals installed.
- b. Water treatment is complete.
- c. Systems are flushed, filled and air purged.
- d. Strainers are pulled and cleaned.
- e. Control valves are functioning per the sequence of operation.
- f. All shutoff and balance valves have been verified to be 100% open.
- g. Pumps are started and proper rotation is verified.
- h. Pump gauge connections are installed directly at the pump inlet and outlet flange or in discharge and suction pipe prior to any valves or strainers.
- i. VFD start-up is complete and all safeties are verified.
- j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing on each system according to the procedures contained in the latest version of the AABC National Standards for Total System Balance and in this Section.
- B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain approved submittals and any manufacturer-recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare a single-line schematic diagram of systems for the purpose of identifying HVAC components.

- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check condensate drains for proper connections and functioning.
- H. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow as follows:
 - a. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 - 3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows.

1. Measure airflow of sub-main and branch ducts.
 2. Adjust sub-main and branch duct volume dampers for specified airflow.
 3. Re-measure each sub-main and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure airflow at all inlets and outlets.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after all have been adjusted.
- D. Verify final system conditions
1. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust, if necessary. Measure and record all operating data.
 6. Record final fan-performance data

3.7 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans: Plus or minus 5 percent.
 2. Air Outlets and Inlets: Plus or minus 5 percent.
 3. Minimum Outside Air: Zero to plus 10 percent.
 4. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.
 5. Heating-Water Flow Rate: Plus or minus 5 percent.
 6. Cooling-Water Flow Rate: Plus or minus 5 percent.

3.8 FINAL TEST & BALANCE REPORT

- A. The report shall be a complete record of the HVAC system performance, including conditions of

- operation, items outstanding, and any deviations found during the T&B process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and test results that appear in the reports must be made on site and dated by the AABC technicians or test and balance engineers.
- B. The report must be organized by systems and shall include the following information as a minimum:
1. Title Page
 - AABC Certified Company Name
 - Company Address
 - Company Telephone Number
 - Project Identification Number
 - Location
 - Project Architect
 - Project Engineer
 - Project Contractor
 - Project Number
 - Date of Report
 - AABC Certification Statement
 - Name, Signature, and Certification Number of AABC TBE
 2. Table of Contents
 3. AABC National Performance Guaranty
 4. Report Summary
 - The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.
 5. Instrument List
 - Type
 - Manufacturer
 - Model
 - Serial Number

- Calibration Date

6. T&B Data

- Provide test data for specific systems and equipment as required by the most recent edition of the *AABC National Standards*.
- C. One copy of the final test and balance report shall be sent directly to the engineer of record. Provide five (5) additional copies to the contractor.

3.9 ADDITIONAL BALANCING REQUIREMENTS

- A. Compensate for condition of filters at time of balancing so that system will deliver proper amount of air when filters become dirt-laden and nearly due for replacement.
- B. Record positions of outdoor, return, and relief dampers as set for cooling cycle; vortex dampers, and bypass dampers.
- C. Adjust duct volume dampers to minimize outlet damper throttling.
- D. Permanently mark position of balancing dampers for future reference.
- E. Air quantities shall be balanced to the tolerance of -5%/+10%.
- F. The balancing agency will witness all duct leakage testing and will provide a certified report on these tests.
- G. Provide Xerox copy or a plan drawing of duct configuration and indicate on as-built drawings where duct traverses are taken. This information shall be included in both the interim and final balance report.

END OF SECTION 230593

SECTION 230713 - DUCTWORK INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Ductwork insulation.
- B. Insulation jackets.

1.2 RELATED WORK

- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 233100 - HVAC Ducts and Casings.
- C. Section 233300 - Air Duct Accessories.

1.3 REFERENCES

- A. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- B. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- C. UL 723 - Surface Burning Characteristics of Building Materials.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.

1.4 QUALITY ASSURANCE

- A. Submit product data under provisions of Section 013300.
- B. Include product description, list of materials and thickness for each service, and locations.
- C. Submit manufacturer's installation instructions under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Johns Manville.
- B. Certainteed.
- C. Knauf.
- D. Armstrong.
- E. Dow.
- F. Substitutions: Approved equal under provisions of Section 012500.

2.2 MATERIALS

- A. Type A: .75 pcf Flexible glass fiber; ANSI/ASTM C553; commercial grade; 'k' value of .27 at 75 degrees F; 0.002 inch foil reinforced kraft facing for air conditioning ducts.

- B. Type B: 3.0 pcf Rigid glass fiber; ANSI/ASTM C612 Class 1; value of 0.23 at 75 degrees F; 0.002 inch white kraft-foil facing for air conditioning ducts.
- C. Type D: Expanded, closed cell elastomeric, flexible insulation with 12 mil white laminate covering: ANSI/ASTM C534; 'k' value of .27 at 75 degrees F. Armacell Arma Tuff.
- D. Type E: (For ductwork sound lining) 3.0 PCF rigid fiber glass board; ASTM C1071 Type 2; ASTM G21; 'k' value of 0.23 at 75 degrees F; black mat facing. Knauf Insulation Atmosphere Rigid Plenum Liner.
- E. Adhesives: Fire-retardant type. Compatible with insulation, Armstrong 520, Benjamin Foster 85-75, Childers Chil-Seal CP-50A MV1 coating and adhesive or approved equal.
- F. Lagging Adhesive: Fire resistive to UL 723.
- G. Impale Anchors: Galvanized steel, 12 gage, welded to duct.
- H. Joint Tape: Self-adhesive type matching insulation jacket.

2.3 JACKETS

- A. Indoors - Factory applied vapor barrier facing of type specified with insulation.
- B. Outdoors - Aluminum jackets, ASTM B209, 0.20 inches thick, smooth finish.
- C. Mechanical Rooms – 8 oz. canvas jacket.

2.4 ACCESSORIES

- A. Adhesives: Compatible with insulation. Armstrong 520, Benjamin Foster 85-75, Childers Chil-Seal CP-50A MV1 coating and adhesive or approved equal.
- B. Insulation Bands: 3/4" wide, .007 inches thick aluminum.
- C. Metal Jacket Bands: 3/8" wide, 0.15 inches thick aluminum.

PART 3 EXECUTION

3.1 PREPARATION

- A. Install materials after ductwork has been tested and approved.
- B. Clean surfaces for adhesives.
- C. Coordinate with other divisions so that duct mounted sensors, damper operators, etc. are installed with proper mounting brackets to allow insulation to run continuously around the perimeter of the duct, and so that all penetrations can be sealed to protect the integrity of the vapor barrier.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Type A Insulation:
 - 1. Prior to installing insulation, ducts shall be clean, dry and tightly sealed at joint.
 - 2. Duct insulation shall be cut to stretch out dimension recommended by manufacturer.

3. Staple seams on 6" centers and then seal with self-adhesive joint tape. On ducts 24" or wider insulation shall be secured with pins welded to duct and speed clip washers on 18" centers on bottom of duct. Seal punctures with joint tape or vapor barrier mastic.
- C. Type B Insulation:
1. Prior to installing insulation on ducts shall be clean, dry and tightly sealed at joints.
 2. Insulation shall be secured to ductwork with pins welded to duct at 12" centers and no more than 3" from the edges of the insulation. Provide additional pins at cross breaking on ducts. Provide clips over pins and pressure sensitive patches or vapor sealing mastic.
 3. At seams and butt joints ship lap edges and staple. Apply 3" wide pressures sensitive tape over seams. In lieu of ship lapping and stapling use 5" wide pressure sensitive tape.
- D. Type D Insulation:
1. Secure insulation to ductwork with smooth side out using insulation manufacturer's adhesive on both contacting surfaces.
 2. Fill joints with insulation manufacturer's adhesive.
 3. Apply layers with staggered seams secured with insulation manufacturer's adhesive where necessary to obtain specified thickness.
 4. Surface Finish: Apply two coats of insulation manufacturer's protective finish as recommended by manufacturer.
 5. For installations in animal husbandry area seal joints with white mastic to provide a tight seal and smooth uniform appearance.
- E. Type E Insulation:
1. Install insulation in metal duct and plenums operating at 250 degrees F service temperature or less and velocities of 5,000 ft/min or less.
 2. Liner shall be applied with the treated surface facing toward the air stream.
 3. Mechanical fasteners shall not compress the liner more than 1/8" and shall be installed perpendicular to the airstream surface. All fasteners must meet "Standard for Mechanical Fasteners MF-1-1975.
 4. Adhesives which conform to ASTM C916 shall be applied to the sheet metal with at least 90% coverage.
 5. All internal duct areas designated to be lined shall be completely covered with liner. Traverse joints shall be firmly butted together with no gaps, and coated with adhesive. All exposed leading edges shall be coated with adhesive.
 6. Mechanical fasteners shall be used to secure liner and spaced in accordance with manufacturer's instructions.
 7. Corner joints shall be overlapped so no gaps are present. Top pieces shall be supported by side pieces.
 8. All longitudinal joints shall be coated with adhesive conforming to ASTM C916 at velocities over 2,500 ft/min.

9. All damaged areas to the airstream surface shall be repaired with an adhesive that conforms to ASTM C916.

F. Surface Finish

G. Continue insulation with vapor barrier through all wall penetrations, except at fire dampers.

3.3 SCHEDULE

DUCTWORK	TYPE	THICKNESS	FINISH
Supply Air Ductwork			
Air Ductwork Concealed-Mech Rm	A	1-1/2"	Foil Faced Kraft

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED WORK

- A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment
- B. Section 230553 - Identification for HVAC Piping and Equipment

1.3 REFERENCES

- A. ANSI/ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- B. ANSI/ASTM C547 - Mineral Fiber Preformed Pipe Insulation.
- C. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
- D. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- E. ASTM E84 - Surface Burning Characteristics of Building Materials.
- F. NFPA 255 - Surface Burning Characteristics of Building Materials.
- G. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- H. UL723 - Surface Burning Characteristics of Building Materials.
- I. Factory Mutual Research Corporation - Simulated Pipe Chase Test.

1.4 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with three years minimum experience.
- B. Materials: Flame spread/fuel contributed/smoke developed rating of 25/50/50 in accordance with ASTM E84, latest revision. In addition, the product when tested will not melt or drip flaming particles, and the flame shall not be progressive. All materials shall pass simulated end-use fire tests.
- C. The materials shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity, and water vapor transmission (WVT).

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 013300.

- B. Include product description, list of materials and thickness for each service, and locations
- C. Submit manufacturer's installation instructions under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Pittsburg-Corning.
- B. Johns Manville / Schuller.
- C. Knauf.
- D. Armacell.
- E. Certainteed.
- F. Dow.
- G. Substitutions: Under provisions of Section 012500.

2.2 INSULATION

- A. Type A: Glass Fiber insulation; ANSI/ASTM C547; 'k' value of 0.24 at 75 degrees F; noncombustible
- B. Type D: Cellular foam; flexible, plastic; 'k' value of 0.27 at 75 degrees F. Armacell AP/ Armaflex white insulation. Insulation shall have a maximum WVT coefficient of 0.08 perm-inches when tested in accordance with ASTM E96, Procedure A.

2.3 JACKETS

- A. Interior Applications:
 - 1. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
 - 2. PVC Jackets: Service pipe sizes 2" and smaller, one piece, pre-molded type for fittings.
- B. Exterior Applications:
 - 1. Weather resistant protective finish compatible with insulation system, Armstrong Armaflex Finish or equal. Finish shall include 10 X 10 Leno weave glass mesh adhered with Armstrong 520 adhesive and two coats of WB Armstrong Finish, color as selected by Owner.

2.4 ACCESSORIES

- A. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.
- B. Finishing Cement: ASTM C449.
- C. Adhesives: Compatible with insulation, Armstrong 520, Benjamin Foster 85-75, Childers Chil-Seal CP-50A MV1 coating and adhesive or approved equal.
- D. Insulation Bands: 3/4 inches wide 0.020 inches thick ASTM B-209 aluminum.

- E. Metal Jacket Bands: 3/4 inches wide, 0.020 inches thick ASTM B-209 aluminum.
- F. Cellular foam joint sealant: Pittsburgh Corning Pittseal 444.

PART 3 EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.
- B. Coordinate with other trades so that valve stems, operators, thermometer and control sensor wells, etc. are installed with proper mounting brackets and extensions are provided to allow insulation to run continuously and so that all penetrations can be sealed to protect the integrity of the vapor barrier.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions. Keep insulation dry and protected from damage.
- B. Continue insulation with vapor barrier through penetrations, sleeves and inside hangers. Stagger longitudinal joints on all insulation.
- C. In exposed piping, locate insulation and over seams in least visible location.
- D. On insulated piping with operating temperatures below 60 degrees or above 140 degrees, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. On insulated piping conveying fluids between 60 and 140 degrees F, do not insulate valves, flanges and unions at equipment, but bevel and seal ends of insulation at such locations with vapor barrier cement.
- F. Provide an insert, not less than 12 inches long, of same thickness and contour as adjoining insulation between support shield and piping, but under the finish jacket, on all piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be type B or Type C heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used.
- G. Neatly finish insulation at supports, protrusions, and interruptions.
- H. Jackets:
 - 1. Indoor, concealed Applications: Insulated pipes with type A insulation shall have standard jackets with vapor barrier, factory-applied. Insulate fittings, joints and valves, with operating temperature above 140 degrees or below 60 degrees with insulation of like material and thickness as adjoining pipe, and finish with preformed PVC or aluminum fitting covers. Pipe valves and fittings insulated with type D insulation need no additional vapor barrier jacket.
 - 2. Outdoor, Exposed Applications: Outdoor piping with type "D" insulation shall receive 10 X 10 Leno weave glass mesh and two coats of weatherproof coating.
- I. Type A Insulation - Operating Temperature Above 60 Degrees:
 - 1. Pipe Insulation: Insulate all piping in a neat, workmanlike fashion in accordance with thicknesses listed in schedule. Jackets and butt strips.

2. Fittings: Where the factory-premolded one-piece PVC or two piece aluminum fitting covers are to be used, the proper factory precut insulation of like material and thickness as adjoining pipe shall be applied to the fitting. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. The fitting cover is then secured by stapling, tack fastening, banding or taping the ends of the adjacent pipe covering.

J. Type 'D' Insulation:

1. Where possible, insulation shall be slipped over the tubing as a full cylinder. Where necessary to cut, and at all butt joints and fittings, insulation shall be joined by sealing with a waterproof vapor-barrier adhesive, Armstrong 520 or approved equal.
2. On refrigeration piping, insulation shall be slipped over the tubing as a full cylinder. Longitudinal slitting of the insulation is not allowed except on mitered sections at traps, tees, and bends over ninety degrees. Where necessary to cut, and at all butt joints and fittings, insulation shall be joined by sealing with a waterproof vapor-barrier adhesive, Armstrong 520 or approved equal.

3.3 SCHEDULE

PIPING	INSULATION TYPE	PIPE SIZE Inch	THICKNESS Inch
Condensate Drain	A	1/2" 3/4"	1/2" 3/4"
Refrigerant Liquid	D	All	3/4"
Refrigerant Suction and Hot Gas	D	All	3/4"

END OF SECTION 230719

SECTION 230900 - CONTROLS AND INSTRUMENTATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. New digital system of automatic controls for heat pump, unit heater and exhaust fan. Building Automation System (BAS) shall include:
- B. Electric interlock of control system with motors.
- C. Control devices, components, wiring and material.
- D. Power for all control devices provided under this contract.
- E. Instructions.

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230553 – Identification for HVAC Piping and Equipment
- C. Section 233300 – Air Duct Accessories
- D. Drawings – Sequence of Operation

1.3 QUALITY ASSURANCE

- A. Material and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be the manufacturer's latest standard design that complies with the specification requirements.
- B. Install system using competent workman who are fully trained in the installation of temperature control equipment.
- C. Single source responsibility of the supplier shall be the complete installation and proper operation of the control system and shall include debugging and proper calibration of each component in the entire system.
- D. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.
- E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 01 33 00.
- B. Provide damper shop drawings which show data such as arrangement, velocities, and static pressure drops for each system.

- C. Provide complete operating data, system drawings, wiring diagrams, and written detailed operational descriptions of sequences, and description and engineering data on each control system component. Include sizing as requested. Provide logic diagrams with initial submittals.
- D. At completion of work, submit report of check-out of automatic control system, and as-built control diagrams.
- E. Provide as-built control diagrams for each system, framed under glass for wall mounting.
- F. Submit manufacturer's installation instructions under provisions of Section 01 33 00.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND INSTALLERS

- A. Johnson Controls, Inc.
- B. Substitutions: None.

2.2 SYSTEM DESCRIPTION

- A. Provide necessary materials and field work necessary to connect control components factory supplied as part of equipment controlled, unless specified otherwise. Provide differential pressure switches for status indication. Generally, self contained valves, filter gauges, liquid level controllers and similar instructions, are not to be installed under this section.
- B. Unless specified otherwise, provide all new components, fully modulating and proportional. All relays, control devices, transformers and setpoint adjustment shall be contained within the ATC cabinet. Provide pilot positioners for activators which are sequenced with other components.
- C. All operating controllers and set point adjustments shall be contained in a locking control panel. Sensors or transmitter only shall be located in the space on the support column.

2.3 THERMOSTATS

- A. Provide room thermostats with warmer-cooler slide, single temperature, gradual-acting, adjustable sensitivity. Provide covers with exposed set point adjustment, set point indication. Differential not to exceed 2.0 degrees F with minimum 20 F degrees set point adjustment.
- B. Provide manual reset type freeze protection thermostats with 20 foot element located to ensure maximum protection. Provide averaging thermostats for large duct cross-sectional areas.
- C. For remote bulb elements use either averaging type of suitable length for air or rigid bulb type for liquids. Use stainless steel flanges to support elements in ducts. In liquids, use separable wells. Wells for use with automatic temperature control sensors shall be brass wells with 6-1/2 inch long neck where appropriate.

2.4 CONTROL PANELS

- A. Provide local panels of unitized cabinet type for each system under automatic control. Mount relays, switches, and controllers with control point adjustment in cabinet and temperature indicators, pressure gages, pilot lights, pushbuttons, and clocks and switches flush on cabinet panel face.

- B. Fabricate panels from 12 gage furniture steel with baked enamel finish and hinged key lock door.
- C. Mount panels adjacent to associated equipment on vibration free walls or free standing steel angle supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic name plates for instruments and controls inside cabinet and on cabinet face.
- D. Also on this panel, or adjacent wall, mount a framed and glazed control diagram complete with operating instructions.

2.5 CONTROL DAMPERS

- A. Dampers shall be Class 1 as specified in Section 23 33 00. Provide electric operators for all dampers. Provide one motor for each damper section.

2.6 ELECTRICAL WORK

- A. Electrical work shall be provided under this section in accordance with requirements as specified under Division 16. All control wiring exposed to view, in walls or where subject to physical damageshall be run in conduit with compression fittings. Wiring above ceilings may be run free but shall be plenum rated. Provide all relays, switches, wiring, etc. required to accomplish the sequence of controls.
- B. Maximum control voltage shall be 120 volts, provide all necessary control transformers.

2.7 FIELD DEVICES

- A. All devices and equipment shall be approved for installation in Baltimore City.
- B. Temperature Sensors
- C. Dampers
- D. Damper Operators
- E. Freezestats
- F. Electric Thermostats
- G. Control Wiring

PART 3 EXECUTION

3.1 SEQUENCE OF OPERATION

- A. Refer to drawings.

3.2 HARDWARE INSTALLATION

- A. Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats 60 inches above floor.

3.3 ON SITE TESTING

- A. Provide Engineer approved operation and acceptance testing of the complete system. The Engineer will witness all tests.
- B. Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on line. All testing, calibrating, adjusting and final field tests shall be completed by the installer.
- C. Compliance Inspection Checklist: Submit in the form requested, the following items of information to the Owner's Representative and Architect/Engineer for verification of compliance to the project specifications. Failure to comply with the specified information shall constitute non performance of the contract. The contractor shall submit written justification for each item in the checklist that he is unable to comply with. The Owner's Representative and the Architect/Engineer will initial and date the checklist to signify contractor's compliance before acceptance of system.
 - 1. Verify to the Owner's Representative and Architect/Engineer in letter form that supplier has in place support facility. Letter shall show location of support facility, name and titles of technical staff, engineers, supervisors, fitters, electricians, managers and all other personnel responsible for the completion of the work on this project.

3.4 SERVICE AND GUARANTEE

- A. General Requirements: Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after completion of successful performance test. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and non scheduled work.
- B. Description of Work: The adjustment and repair of the system includes all computer equipment, software updates, transmission equipment and all sensors and control devices. Provide the manufacturer's required adjustments and all other work necessary.
- C. Personnel: Provide qualified personnel to accomplish all work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.
- D. Schedule of Work: Provide two minor inspections at 6 month intervals and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude, and all work required as specified. Written reports of observations and system condition shall be submitted to Owner and Engineer. Schedule major inspections in June and December. Minor inspections shall include visual checks and operational tests of all equipment delivered. Major inspections shall include all work described for minor inspections and the following work:
 - 1. Clean all equipment, including interior and exterior surfaces.
 - 2. Check and calibrate each field device. Check all analog points.
 - 3. Run all diagnostics and correct all previously diagnosed problems.
 - 4. Resolve and correct any previous outstanding problems.
- E. Emergency Service: Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. Furnish owner with a telephone number where service representative can be reached at all

- times. Service personnel shall be at the site within 24 hours after receiving a request for service. Restore the control system to proper operating condition within 3 days.
- F. Operation: Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the initial performance test.
 - G. Systems Modifications: Provide any recommendations for system modification in writing to Owner. Do not make any system modifications, including operating parameters and control settings, without prior approval of Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

3.5 TRAINING

- A. The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays as follows:
- B. Provide 2 hours of training for Owner's operating personnel. Training shall include:
 - 1. Explanation of drawings, operations and maintenance manuals.
 - 2. Walk thru of the job to locate control components.
 - 3. Explanation of adjustment, calibration and replacement procedures

END OF SECTION 230900

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe, fittings, and connections.

1.2 RELATED WORK

- A. Section 230523 - General-Duty Valves for HVAC Piping
- B. Section 230529 - Hangers and Supports for HVAC Piping and Equipment
- C. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment
- D. Section 230719 - HVAC Piping Insulation

1.3 REFERENCES

- A. ANSI/ASME B16.3 - Malleable-Iron Threaded Fittings.
- B. ANSI/ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.
- F. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- G. ASTM A234 - Wrought Carbon Steel and Alloy Steel.
- H. ASTM A536 - Ductile Iron Castings.
- I. ASTM D-1785 - PVC Piping
- J. ANSI/AWS D1.1 - Structural Welding Code.
- K. ASTM B88 - Seamless Copper Water Tube.
- L. ASTM B280 - Seamless Copper Tube for Air Conditioning.
- M. FS WW-P-521 - Pipe Fittings, Flange Fittings, and Flanges: Steel and Malleable Iron (Threaded and Butt Welding) Class 150.

1.4 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ASME Code and applicable State Labor regulations.

- B. Employ certified welders in accordance with ASME Section 9 and ANSI/AWS D1.1.

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 01330.
- B. Include product description, list of materials for each service and locations.
- C. Indicate pipe materials used, joining methods, supports, floor and wall penetration seals.

PART 2 PRODUCTS

2.1 PIPE AND TUBE

- A. Copper Water Tube: ASTM B88, type, grade and temper as scheduled; seamless.

2.2 PIPE AND TUBE JOINTS AND FITTINGS

- A. Copper Pipe Fittings: ANSI/ASME B16.22 or B16.18, pressure fittings.

2.3 UNIONS AND COUPLINGS

- A. Pipe Size 2-1/2 Inches and Under: Bronze, ground joint for copper or brass pipe, soldered ends.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe, or groove where permitted by these specifications.
- B. Remove scale and dirt, inside and outside, before assembly.
- C. Remove welding slag or foreign material from pipe and fitting materials.
- D. Cut all pipes accurately to measurements established at structure. Work into place without springing or forcing, properly clearing all windows, doors or other openings. Cut pipe and nipples evenly; cut threads clean, remove burrs, ream ends to full inside bore. Install to permit free expansion and contraction without causing misalignment of piping or any damage to either building or piping. Grade all piping to low points to permit complete drainage of system. At bottom of water risers and at all low points provide a drain valve. Make all changes of direction with fittings except as otherwise noted. Make pipe connections to equipment in accordance with indicated sizes and details or as directed. Cap or plug all equipment and pipe line openings during installation to exclude dirt and foreign material.
- E. Provide unions at each piece of equipment, in bypasses around equipment and in long runs or piping to permit convenient disassembly for alteration or repairs. Unions must be accessible after building is completed. Mechanical pipe couplings may be used as unions where mechanical pipe couplings are allowed elsewhere in this specification.
- F. Provide test connections for thermometers and pressure gauges at each piece of equipment.

- G. Where changes in pipe sizes occur, use only reducing fittings. Use eccentric fittings where required to prevent pocketing of air and/or water.

3.2 COPPER PIPE CONNECTIONS

- A. Form hot soldered joints in copper, brass, or bronze fittings with non lead based solder. Solder shall be Worthington Silver Bearing Alloy Lead-Free (95%-Tin, 4.8%-Copper, 0.2%-Silver) or approved equal. Fittings shall be clean and deburred prior to making up joints.
- B. Make connections to equipment and branch mains with unions.

3.3 TESTS

- A. Test all piping and prove tight. Notify Architect when tests will take place and submit test results prior to covering or enclosing any piping. Before enclosing, test piping which will be concealed. Replace and re-test to Architect's satisfaction any pipe or fittings broken or damaged under test. Caulking or peening joints will not be permitted.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, thermostatic traps and elements, other parts which are not designed to stand pressures use in testing piping.
- C. Test as follows:
 - 1. Condensate Drain 100 psig hydrostatic
- D. Hold indicated pressures constant without pumping for such period of time as directed by Architect. While under pressure, visually inspect each joint, weld or other connection to determine leakage. Apply soap suds test to all systems conveying gases under pressure.

3.4 PAINTING

- A. Paint all above ground pipe and hangers which are not copper, insulated or galvanized as described in Section 09900 PAINTING.

3.5 SCHEDULE OF PIPE AND FITTINGS

- A. AIR CONDITIONING CONDENSATE:
 - 1. Pipe copper, type "L", hard drawn
 - 2. Fittings sweat type, wrought copper
 - 3. Couplings sweat type, wrought copper
 - 4. Unions sweat type, wrought copper, ground joint 150 lb.
 - 5. Joints Joints soldered per Paragraph 3.2A

END OF SECTION 232113

SECTION 232313 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe, fittings and connections.

1.2 RELATED WORK

- A. Section 232313 - Refrigerant Piping Specialties
- B. Section 230529 - Hangers and Supports for HVAC Piping and Equipment
- C. Section 230548 - Vibration and Seismic controls for HVAC Piping and Equipment

1.3 REFERENCES

- A. ANSI/ASME B16.3 - Malleable-Iron Threaded Fittings.
- B. ANSI/ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.

PART 2 PRODUCTS

2.1 PIPE AND TUBE

- A. Copper Water Tube (Refrigeration Service): ASTM B280, type, ACR or OXY grade, hard temper as scheduled; seamless

2.2 PIPE AND TUBE JOINTS AND FITTINGS

- A. Copper Pipe Fittings: ANSI/ASME B16.22 or B16.18, pressure fittings.

2.3 UNIONS AND COUPLINGS

- A. Pipe Size 2-1/2 Inches and Under: 150 psi malleable iron for threaded ferrous piping; bronze, ground joint for copper or brass pipe, soldered ends.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe, or groove where allowed.

- B. Remove scale and dirt, inside and outside, before assembly.
- C. Cut all pipes accurately to measurements established at structure. Work into place without springing or forcing, properly clearing all windows, doors or other openings. Cut pipe and nipples evenly; cut threads clean, remove burrs, ream ends to full inside bore. Install to permit free expansion and contraction without causing misalignment of piping or any damage to either building or piping. Make all changes of direction with fittings except as otherwise noted. Make pipe connections to equipment in accordance with indicated sizes and details or as directed. Cap or plug all equipment and pipe line openings during installation to exclude dirt and foreign material.
- D. Provide unions at each piece of equipment, in bypasses around equipment and in long runs or piping to permit convenient disassembly for alteration or repairs. Unions must be accessible after building is completed. Mechanical pipe couplings may be used as unions where mechanical pipe couplings are allowed elsewhere in this specification.

3.2 COPPER PIPE CONNECTIONS

- A. Form joints in refrigeration piping with non-flux type 15% silver brazing alloy. Trickle dry nitrogen through pipe during brazing process to prevent a buildup of oxidation products.

3.3 TESTS

- A. Test all piping and prove tight. Notify Architect when tests will take place and submit test results prior to covering or enclosing any piping. Before enclosing, test piping which will be concealed. Replace and re-test to Architect's satisfaction any pipe or fittings broken or damaged under test. Caulking or peening joints will not be permitted.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, thermostatic traps and elements, other parts which are not designed to stand pressures use in testing piping.
- C. Test as follows:
 - 1. Refrigeration – discharge450 psig dry nitrogen
 - 2. Refrigeration – suction250 psig dry nitrogen
- D. Hold indicated pressures constant without pumping for such period of time as directed by Architect. While under pressure, visually inspect each joint, weld or other connection to determine leakage.
- E. Refrigeration Piping:
 - 1. Upon completion of installation of the air conditioning equipment, test all factory as well as field refrigerant piping with an electronic type leak detector to acquire a leak-tight refrigerant system. If leaks are detected at the time of installation or during the guarantee period, remove the entire refrigerant charge from the system, correct the leaks and retest the system.
 - 2. After system is found to be without leaks, evacuate the system using a reliable gauge and a vacuum pump capable of pulling a vacuum of at least 1 mm Hg absolute. Evacuate system in strict accordance with the triple-evacuation and blotter method or in strict accordance with equipment manufacturer's printed instructions. Hold vacuum for twenty four hours. System leak testing, evacuation, dehydration, and charging with refrigerant shall comply with ARI standard 260.

3.4 SCHEDULE OF PIPE AND FITTINGS

A. REFRIGERATION PIPING:

1. Pipe: Type K copper, type OXY, hard temper cleaned with ends capped prior to shipment
2. Fittings: Socket type wrought copper
3. Joints: 15% Non-flux silver-brazing alloy

END OF SECTION 232313

SECTION 232316 - REFRIGERATION SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Liquid indicators.
- B. Air Dryers.
- C. Piping installation.

1.2 REGULATORY REQUIREMENTS

- A. Comply with applicable regulations and mechanical refrigeration codes.
- B. Submit manufacturer's installation instructions under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Sporlan.
- B. Henry.
- C. Alco.
- D. Substitutions: Under provisions of Section 012500.

2.2 LIQUID INDICATORS

- A. Double port type with copper or brass body, and flared or solder ends.
- B. Provide removable seal caps on each port for inspection of refrigerant condition.
- C. Provide full size liquid indicators in main liquid line leaving condenser. If receiver is used, install in liquid line leaving receiver

2.3 FILTER DRIERS

- A. Angle type, with brass shell and using combined straining and drying material.
- B. Employ replaceable desiccant material.
- C. Acceptable in lieu of separate strainers and driers.
- D. Provide three-valve by-pass assembly.

2.4 CHARGING VALVES

- A. General purpose type with brass body, flared or soldered ends, and removable valve core.
- B. Provide valve inlet with quick coupling connection for ease of charging.
- C. Provide refrigerant charging connections on inlet and outlet to compressor.

2.5 FILTER DRIERS

- A. Angle type with brass shell and wiring straining and drying material.
- B. Employ replaceable desiccant material.
- C. Provide three valve bypass assembly.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions and ASHRAE 15. Provide gate valves at inlet and outlet connections to condensing unit.

3.2 PIPING

- A. Upon completion of installation of the air conditioning equipment, test all factory as well as field refrigerant piping with an electronic type leak detector to acquire a leak-tight refrigerant system. If leaks are detected at the time of installation or during the guarantee period, remove the entire refrigerant charge from the system, correct the leaks and retest the system.
- B. After system is found to be without leaks, evacuate the system using a reliable gauge and a vacuum pump capable of pulling a vacuum of at least 1 mm Hg absolute. Evacuate system in strict accordance with the triple-evacuation and blotter method or in strict accordance with equipment manufacturer's printed instructions. Hold vacuum for twenty four hours. System leak testing, evacuation, dehydration, and charging with refrigerant shall comply with ARI standard 260.

3.3 FILTER-DRIERS

- A. Install with bypass assembly to permit isolation for servicing.

3.4 EXPANSION VALVES

- A. Locate expansion valve sensing bulb immediately after evaporator outlet on suction line.

END OF SECTION 232316

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Ductwork and plenums.
- B. Fasteners.
- C. Sealants.
- D. Duct cleaning.

1.2 RELATED WORK

- A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment
- B. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment
- C. Section 230553 - Identification for HVAC Piping and Equipment
- D. Section 230593 - Testing, Adjusting and Balancing for HVAC
- E. Section 233300 - Air Duct Accessories
- F. Section 233600 – Air Terminal Units
- G. Section 233700 - Air Outlets and Inlets

1.3 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilating System.
- B. SMACNA - HVAC Duct Construction Standards.

1.4 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions.
- B. Low Pressure: Static pressure in duct less than 2 inch wg and velocities less than 2000 fpm.

1.5 SUBMITTALS

- A. Submit shop drawings, product data, and samples under provisions of Section 013300.
- B. Submit shop drawings and samples of duct fittings, including particulars such as gauge sizes, welds, and configurations prior to start of work.
- C. Confirm ductwork has been fabricated and installed in accordance with recommendations and SMACNA standards and conforms to NFPA and BOCA requirements.

- D. At project closeout, submit record drawings of installed ductwork and products, along with data on volume control devices, fire dampers, connectors, sealants and maintenance information.

PART 2 PRODUCTS

2.1 MATERIALS.

- A. Air Conditioning and General Exhaust Ducts: Galvanized steel, lock-forming quality, having zinc coating of 1/25 ounces per square foot for each side, conforming to ASTM 527 and ASTM 525.
- B. Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.
- C. Sealant: Water resistant, fire resistive, compatible with mating materials.

2.2 FABRICATION

- A. Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.
- B. Construct ductwork to NFPA 90A.
- C. Size round ducts installed in place of rectangular ducts from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sized permitted except by written permission.
- D. Complete metal ducts within themselves with no single partition between duct. Where width of duct exceeds 18 inches, cross brace for rigidity. Open corners are not acceptable.
- E. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior. Seams in grease exhaust duct shall be continuously welded.
- F. Constructs T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on center line. Where not possible and where rectangular elbows used, provide air foil type turning vanes except in grease exhaust duct.
- G. Increase duct sized gradually, not exceeding 15 degrees divergence wherever possible. Maximum divergence upstream of equipment to be 30 degrees and 30 degrees convergence downstream.
- H. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braces and stiffened so as not to breathe, rattle, vibrate, or sag. Caulk all duct joints and connections with sealant as ducts are being assembled. Sealant shall be Hardcast or approved equal.
- I. Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10 percent duct area, split into two ducts maintaining original area.

2.3 LOW PRESSURE DUCT GAGES - GALVANIZED STEEL

- A. Rectangular Ducts:

Maximum Width	Minimum
<u>In Inches</u>	<u>USS Gage</u>

Up to 12	26
13 to 30	24
31 to 54	22

B. Round Ducts:

Duct Diameter <u>In Inches</u>	Minimum <u>USS Gage</u>
Up to 13	26
14 to 22	24
23 to 36	22
37 to 50	20
51 to 60	18
61 to 84	16

2.4 DUCT GAGES

- A. Contractor shall provide minimum USS gage ductwork indicated above where this gage is heavier than the minimum required by SMACNA.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring. Coordinate with balancing contractor, control contractor and all other trades for locations and quantities.
- B. Clean new duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes. During construction phasing, provide temporary closure over open end ducts which shall prevent entrance of dust and debris until time connections are to be completed.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Connect diffusers or troffer boots to ducts with galvanized steel collars.
- E. At each point where ducts pass through partitions, seal joints around duct with non-combustible material. Provide galvanized steel sleeves through structural walls and at fire dampers.
- F. Routing: Locate ductwork runs, except as otherwise noted, vertically and horizontally and avoid diagonal runs. Locate runs as indicated in plans, sections, and details on drawings. If not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment.

- G. Where ducts pass through partitions and walls and are exposed to view, close spaces between construction opening and duct or duct insulation with sheetmetal flanges of same gauge as duct. Overlap opening on four sides or diameter by at least 1-1/2". Fasten to duct and substrate.
- H. Coordinate ductwork installation with all other trades and with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- I. Where ductwork is to be insulated, assure duct mounted devices have extended necks, operators, etc. to allow complete and continuous insulation of ductwork and maintain insulation vapor barrier continuity.
- J. Medium pressure ductwork and outdoor ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual.

3.2 SCHEDULE OF DUCT CONSTRUCTION

<u>SERVICE</u>	<u>CONSTRUCTION</u>	<u>SEAL CLASS</u>
Supply Air	Low Pressure, 2"	A
Return and General Exhaust	Low Pressure, 2"	A

END OF SECTION 233100

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Access Doors.
- B. Balancing and Control Dampers.
- C. Flexible Connections
- D. Louvers.
- E. Germicidal UV Light.

1.2 RELATED WORK

- A. Section 230713 - Ductwork Insulation.
- B. Section 233100 - HVAC Duct and Casings.

1.3 REFERENCES

- A. NFPA 90 - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.4 QUALITY ASSURANCE

- A. Accessories shall meet the requirements of NFPA 90.
- B. Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.
- C. Fire dampers shall be UL listed and constructed in accordance with UL Standard 555.
- D. Fusible links on fire dampers shall be constructed to UL Standard 33.
- E. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.
- F. Access doors shall be UL labeled.
- G. Louver performance requirements: Provide units whose performance ratings have been determined in compliance with Air Movement and Control Association (AMCA) Standard 500.
 - 1. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures, except as otherwise indicated.
 - 2. Field Measurements: Verify size, location and placement of louver units prior to fabrication.
 - 3. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in shop to greatest extent possible and

disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Provide units of a single assembly wherever possible.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 013300.
- B. Submit shop drawings of factory fabricated assemblies.
- C. Submit samples, under provisions of Section 013300, of shop fabricated assemblies as requested.
- D. Submit manufacturers' installation instruction under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Air Balance
- B. Ruskin.
- C. American Warming and Ventilating Company.
- D. Johnson Controls.
- E. Prefco.
- F. Airstream.
- G. Greenheck
- H. Aerosonics
- I. Substitutions: Approved equal under provisions of Section 012500.
- J. Manufacturer's as listed under individual items.

2.2 ACCESS DOORS

- A. Fabricate rigid and close-fitting doors of material matching ductwork in which they are installed with sealing gaskets and quick fastening locking devices. Provide minimum one inch thick insulation with sheet metal cover.
- B. Provide continuous piano-type hinge and one sash lock for sizes up to 16 inch square, continuous piano-type hinge and two compression latches for sizes up to 24 X 24 inch. Doors shall have a maximum air leakage of 0.13 CFM sq. ft. at 0.10" S.P. when tested in accordance with AMCA Std. 500. Provide round transparent plexiglass window where specified. Doors shall be equal to Ruskin Models ADH22 or ADHW22.
- C. For larger access doors, provide continuous piano-type hinge, extruded aluminum frame with mitered corners and 24 gauge galvanized steel panel, aluminum framed 9" x 9" 1/4" wire glass

window where specified, heavy duty extruded aluminum frame with 1-1/2" front flanges, neoprene seals, two dual acting handles for doors to 48" high and three for 51" and higher, 3/4" from board insulation R value 5.5, and low leakage of less than 0.1 CFM per inch of door perimeter based on AMCA 500 tests. Equal to Ruskin Model GPAD.

D. All access doors shall be rated for the specified seal class of the associated ductwork.

2.3 BALANCING DAMPERS

A. Fabricate of material matching ductwork in which they are installed, minimum 16 gauge, and provide with quadrants or adjustment rod and lock screw. Where duct is insulated provide brackets to allow insulation to be installed continuously behind operators, quadrants, etc..

B. Fabricate splitter dampers of double thickness sheet metal to stream line shape properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.

C. Fabricate single blade dampers for duct sizes to 9-1/2 X 30 inch.

2.4 CONTROL DAMPERS

A. Fabricate isolation and all control dampers of opposed blade pattern with maximum blade sizes 8 x 76 inches. Assembly 1/16 inch extruded aluminum air foil blades on 13 gauge prime coated or galvanized steel channel frame, mechanically joined with suitable hardware. Dampers shall have a santoprene gasketed edges and self-compensating stainless steel blade end seals, minimum 3/8" square steel, zinc plated blade pins, self-lubricating acetyl or bronze bearings, and 1/8" rolled steel zinc plated linkage concealed in end channel of frame. Control dampers shall be tested and rated in accordance with AMCA Standard No. 500, Class 1 control damper, with a maximum leakage of 10 cfm/square foot, based on 1000 fpm approach velocity, and 4' wg static pressure. Equivalent to Johnson Controls, Inc., Model CD-1330 or Ruskin CD40 control damper.

2.5 FLEXIBLE CONNECTIONS

A. Fabricate of neoprene coated flameproof fabric approximately 2 inch wide tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 6 inch intervals.

2.6 GERMICIDAL UV LIGHT SYSTEM

A. Dual lamp system with 254 nm germicidal UV-C, quartz hot filament lamps, auto switching multi-voltage (0.51A/120V thru 0.22A/277V) NEMA IP54 power supply, 6' lamp cables, 6' power cord, and mounting brackets and hardware, Fresh-Aire UV AHU Series 1 or approved equal.

2.7 LOUVERS

A. Materials:

1. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producers to provide required finish.

2. Aluminum Extrusions: ASTM B221, Alloy 6063-T52.

3. Fastenings: Use same material as items fastened, unless otherwise indicated. Fasteners for exterior applications may be hot-dip galvanized, stainless steel or aluminum. Provide

types, gages and lengths to suit unit installation conditions. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.

4. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.
5. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic)

B. Fabrication, General

1. Provide louvers and accessories of design, materials, sizes, depth, arrangement, and metal thicknesses indicated, or if not indicated, as required for optimum performance with respect to airflow; water penetration; air leakage, where applicable (for adjustable units, if any); strength; durability; and uniform appearance.
2. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between louvers and adjoining work.
3. Include supports, anchorages, and accessories required for complete assembly.
4. Provide sill extensions and loose sills made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.
5. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are made necessary by size of louvers. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Stationary extruded aluminum wall louvers shall be of 6063-T5 alloy, minimum thickness .081", horizontal drainable blade design, Ruskin model 'ELF375DX', 4" channel frame, 16 gauge aluminum wire bird screen of 1/2" square mesh 0.063" aluminum wire on interior face. 72" maximum distance between vertical supports. Kynar 500 or Anodize finish, in a color to be selected by Engineer.

1. Free Area: Not less than 55%.
2. Static Pressure Loss: Not more than 0.10" of water gage at an airflow of 800 fpm free area velocity in intake direction.
3. Water Penetration: Not more than 0.010 oz. per sq. ft. of free area at an airflow of 1000 fpm free area velocity.
4. AMCA Certification: Furnish units bearing AMCA Certified Ratings Seal.
5. Secure screens to louver frames with machine screws, spaced at each corner and at 12" o.c. between.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with manufacturer's instructions.

3.2 APPLICATION

- A. Provide access doors for inspection and cleaning before and after filters, coils, fans, automatic damper, at fire dampers, and elsewhere as indicated. Review locations prior to fabrication. Provide access doors with vision panels on all doors larger than 24 x 24. On doors smaller than 24 x 24, provide vision panels at automatic dampers, and generator discharge plenums. Systems subject to condensation shall have solid access doors, without visions panels.
- B. Provide 4 X 4 inch quick opening access doors for inspection at each balancing damper.
- C. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.
- D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and equipment subject to forced vibration.
- E. Where ductwork is to be insulated, assure duct mounted devices have extended necks, operators, etc. to allow complete and continuous insulation of ductwork and maintain insulation vapor barrier continuity.

3.3 LOUVER INSTALLATION

- A. Locate and place louver units plumb, level and in proper alignment with adjacent work.
- B. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.
- C. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.
- D. Provide concealed gaskets, flashings, joint fillers, and insulations, and install as work progresses to make installations weathertight.
- E. Refer to Division 7 sections for sealants in connection with installations of louvers.

3.4 ADJUSTING, CLEANING, AND PROTECTING

- A. Periodically clean exposed surfaces of accessories, louvers and vents that are not protected by temporary covering to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
- B. Before final inspection, clean exposed surfaces with water and mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

END OF SECTION 233300

SECTION 233400 - HVAC FANS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Inline Exhaust Fan

1.2 RELATED WORK

- A. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- B. Section 23 05 53 – Identification for HVAC Piping and Equipment
- C. Section 23 05 48 – Vibration and Seismic controls for HVAC Piping and Equipment
- D. Section 23 31 00 – HVAC Ducts and Casings
- E. Section 23 33 00 – Air Duct Accessories

1.3 QUALITY ASSURANCE

- A. Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01 33 00.
- B. Submit with shop drawings, operating point plotted on curves and sound ratings at operating conditions.
- C. Submit manufacturers' installation instructions under provisions of Section 01 33 00.

1.5 PROJECT CONDITIONS

- A. Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated, and fan has been run under observation.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide and install items as listed in schedule on the drawings.
- B. Equivalent fan selections shall not decrease motor horsepower (wattage), increase noise level, increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from that specified.
- C. Fan performance based on sea level conditions.

- D. In-Line Exhaust Fans
 - 1. Loren-Cook
 - 2. Penn-Barry
 - 3. Acme
 - 4. Greenheck
 - 5. Substitutions: Under provisions of 012500.

2.2 SELECTION AND BALANCING

- A. Fans shall be catalog rated for 10% greater static pressure than specified at the specified air volume and selected with the specified air volume greater than the air volume at the peak of the fan pressure volume curve. Fan shall provide stable operation down to 80% of the design volume operating at the required speed for the specified conditions.
- B. Provide balanced variable sheaves for motors 15 hp and under, and fixed sheaves for 20 hp and over. Provide additional fixed sheaves and belts to meet balance requirements.
- C. Statically and dynamically balance fans to eliminate vibration of noise transmission to occupied areas of the building.
- D. Provide belt guards on belt driven fans to meet OSHA requirements.
- E. Provide safety screen where inlet or outlet is exposed.

2.3 PAINTING

- A. Prime coat fan wheels and housing factory inside and outside. Paint coating on aluminum parts is not required.

2.4 INLINE EXHAUST FAN

- A. Description: Fan shall be duct mounted, direct driven centrifugal square inline.
- B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
- C. Construction: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Housing shall be predrilled to accommodate universal mounting feet for vertical or horizontal installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure, Unit shall be shipped in ISTA certified transit tested packaging.
- D. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA standard 204-05, balance quality and vibration levels for fans.
- E. Motor: Motor shall be an electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller.
- F. Product: Fan shall be model SQN-D as manufactured by Loren Cook Company.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Supply and install sheaves as necessary for final air balancing.
- B. Set roof mounted fans on curbs.

3.2 FAN SCHEDULE

- A. See Drawings.

END OF SECTION 233400

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Diffusers.
- B. Grilles and registers.

1.2 RELATED WORK

- A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.3 QUALITY ASSURANCE

- A. Make air flow tests and sound level measurements in accordance with applicable ADC equipment test codes and ASHRAE standards.
- B. Manufacturer shall certify cataloged performance and ensure correct application of air outlet types.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 013300.
- B. Submit product data and shop drawings covering each item, together with schedule of outlets.
- C. Submit manufacturer's installation instructions under provisions of Section 013300.
- D. Review requirements of outlets as to size, finish, and type of mounting prior to submitting shop drawings and schedules of outlets.
- E. Check location of outlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Titus.
- B. Nailor.
- C. Price.
- D. Krueger.
- E. Substitutions: Under provisions of Section 012500.

2.2 APPLICATION

- A. Rate units in accordance with ADC standards.
- B. Base air outlet application on space noise level of NC 35 maximum.
- C. Provide supply outlets with sponge rubber seal around edge.
- D. Provide baffles to direct air away from walls, columns, or other obstructions within radius of diffuser operation.
- E. For sidewall supply grilles provide streamlined and individually adjustable blades, depth of which exceeds 3/4 inch maximum spacing. Provide spring tension or other device to set blades. Provide units with horizontal face.

2.3 RETURN, EXHAUST AND TRANSFER REGISTERS AND GRILLES

- A. Titus model 350-RL or approved equal sidewall and ceiling registers, provide streamlined blades, depth of which exceeds 3/4 inch spacing. Provide fixed blades set at 35 degrees, with horizontal face.
- B. Provide 1-1/4 inch margin frame with countersunk screw holes.
- C. Fabricate of aluminum with 20 gauge minimum frames and 22 gauge minimum blades, steel and aluminum with 20 gauge minimum frame, or aluminum extrusions.
- D. Provide registers, with integral gang-operated opposed blade dampers with removable key operator, operable from face.
- E. Transfer Grilles shall be similar to registers but without dampers.
- F. Finish in factory baked white enamel finish.

2.4 SIDEWALL SUPPLIES

- A. Titus Model 300-RL or approved equal steel, double deflection, 3/4" blade spacing, white finish, adjustable blades.
- B. The deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of steel with a 1-1/4-inch wide border on all sides.

2.5 SUPPLY NOZZLE DIFFUSER

- A. The supply nozzle diffuser shall be a Titus TND-AA constructed of heavy gauge aluminum. This nozzle must have directional control no less than 75 degrees of global rotation, 38 degrees in any one direction from center. The flange of the TND-AA shall have a minimum of 5 screw holes on the face of the flange for surface mounting. A felt gasket shall be located between the nozzle and the frame of the ball and socket joint to provide a tight air seal.
- B. An optional mounting ring shall be available for mounting the unit directly to a hard duct. Once installed, the mounting ring shall facilitate the mounting of the nozzle diffuser by simply inserting the diffuser into the mounting ring and rotating the unit approximately 10 degrees.
- C. An aluminum aperture damper with stainless steel hardware shall be operable from the face of the nozzle. The damper shall provide a full range of 1 to 100% airflow.

- D. The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance to the data standards at the time of product introduction or ANSI/ASHRAE Standard 70.
- E. The paint finish shall be white and be an oven-cured electrostatic paint coating. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the STM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

PART 2 EXECUTION

2.1 INSTALLATION

- A. Install items in accordance with manufacturers' instructions.
- B. Paint ductwork visible behind air outlets matte black.

END OF SECTION 233700

SECTION 238126 - SPLIT SYSTEM AIR CONDITIONER

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Condensing unit package.
- B. Companion indoor fan coil unit.
- C. Internal piping and accessories.
- D. Controls.

1.2 RELATED WORK

- A. Section 230553 - Identification for HVAC Piping and Equipment
- B. Section 230719 - HVAC Piping Insulation
- C. Section 232318 - Refrigerant Piping
- D. Section 232316 - Refrigerant Specialties

1.3 QUALITY ASSURANCE

- A. Conform to requirements of UL and applicable codes and provide units which carry the UL label of approval.
- B. Test and rate cooling systems to ARI Standards 210 and 240.
- C. Unit construction shall comply with ANSI/ASHRAE 15 Safety Code and comply with the NEC (National Electric Code). Unit shall be constructed in accordance with UL standards and shall carry the UL label of approval.
- D. Exterior unit cabinet and finish shall be capable of withstanding a 250 hour salt spray test, Federal Standard 141 or ASTM B117.
- E. Organization performing start-up of refrigeration equipment shall be authorized by equipment manufacturer.

1.4 SUBMITTALS

- A. Submit shop drawings, product data and manufacturer's certificate of 5 year warranty for compressor under provisions of Sections 013300 and 230500.
- B. Submit with shop drawings, schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system. Refrigerant piping schematic including sizes shall be approved by condensing unit manufacturer and submitted with condensing unit.
- C. Submit complete pipe sizing data.
- D. Submit manufacturer's installation instructions under provisions of Sections 013300 and 230500.

- E. Submit resume of organization which will be performing startup of refrigeration systems. Startup shall be performed by vendor's authorized startup organization.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Units will be shipped as a single package, and shall be stored and handled per unit manufacturer's recommendations.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Carrier
- B. Trane
- C. York
- D. Substitutions: Approved equal under provisions of Section 012500.

2.2 GENERAL

- A. Outdoor air-cooled split system compressor sections suitable for on-the-ground, rooftop, wall-hung or balcony mounting. Units consist of a rotary compressor, an air-cooled coil, propeller-type draw-through outdoor fan, reversing valve, accumulator, metering devices, and a control box with integrated 24V and RS485 communication. Units discharge air horizontally as shown on the contract drawings. Units function as the outdoor component of an air-to-air heat pump system.
- B. Provide factory matched indoor heat pump fan coil unit.
- C. Provide air cooled condensing unit having a cooling rejection capacity as indicated on the drawings.
- D. Condensing unit at ARI conditions shall have an EER no less than 10.0.
- E. Installation and charging shall conform with latest regulations regarding refrigerant containment and leak prevention.

2.3 MATERIALS

- A. Use corrosion resistant materials for parts in contact with refrigeration.
- B. Provide timer circuits to prevent rapid loading and unloading of compressor.

2.4 CONDENSING UNITS

- A. General: Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure is all the factory wiring, piping, controls, and the compressor.
- B. Unit Cabinet:
 - 1. Unit cabinet is constructed of galvanized steel, bonderized and coated with a baked-enamel finish on the inside and outside.
 - 2. Unit access panels is removable with minimal screws and provides full access to the compressor, fan, and control components.

3. The outdoor compartment is isolated and has an acoustic lining to assure quiet operation.
- C. Fans:
1. Outdoor fans are the direct drive propeller type, and discharges air horizontally. Fans draw air through the outdoor coil.
 2. Outdoor fan motors are totally enclosed, single phase motors with class E insulation and permanently lubricated ball bearings. The motor shall be protected by internal thermal overload protection.
 3. The shaft has inherent corrosion resistance.
 4. Fan blades are non-metallic and statically and dynamically balanced.
 5. Outdoor fan openings are equipped with PVC metal/mesh coated protection grille over the fan.
- D. Compressor:
1. Compressor is the fully hermetic rotary type.
 2. Compressor is equipped with an oil system, operating oil charge, and a motor.
 3. Motor is NEMA rated class E, suitable for operation in a refrigerant atmosphere.
 4. Compressor assembly is installed on rubber vibration isolators.
- E. Outdoor Coil: The coil is constructed of aluminum pre-coated fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
- F. Refrigerant Components: Refrigerant circuit components include a brass external liquid line service valve with service gage port connections, a suction line service valve with a service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, reversing valve.
- G. Controls and Safeties: Operating controls and safeties are factory selected, assembled, and tested. The minimum control functions include the following:
1. Controls:
 - a. Time delay control sequence.
 - b. Automatic outdoor fan motor protection.
 2. Safeties:
 - a. System diagnostics.
 - b. Compressor motor current and temperature overload protection.
 - c. Outdoor fan failure protection.
- H. Electrical Requirements:
1. Unit operates on single phase, 60 hz power at 208/230 volt.

2. Unit electrical power has a single point connection.
3. All power and control wiring must be installed per NEC and all local electrical codes.
4. The unit has high and low voltage terminal block connections.

2.5 INDOOR UNIT

- A. Indoor, direct-expansion, vertical oriented fan coil unit. Unit shall be complete with cooling/heating (heat pump systems only) coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Carrier FV4C performance series fan coil or approved equal.
- B. All components are protected within a rugged, pre-painted galvanized sheet metal cabinet lined with high density insulation with vapor barrier.
- C. High duct static capability. Design meets regulations for cabinet air leakage of less than 2% when tested at 0.5 inches W.C., and cabinet air leakage less than 1.4% at 0.5 inches W.C. when tested in accordance with ASHRAE 193 Standard.
- D. Coil shall be grooved tubing with louvered aluminum fins.
- E. Motors shall be electronically commutating motor (ECM).
- F. Provide fan coil filter cabinet with factory supplied throwaway filter. Provide minimum MERV 8 filter.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- B. Furnish charge of refrigerant and oil.

3.2 ADJUSTING

- A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period. Supply to Owner, one complete charge or lubricating oil in addition to that placed in the system.
- B. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance. Submit complete report of startup including ambient temperature, suction and discharge, superheat, unloading pressure and running amperage, and check out of low ambient controls.
- C. Inspect and test for refrigerant leaks every month during first year of operation.

3.3 SCHEDULE

- A. Refer to equipment notes on drawings.

3.4 CHECK OUT AND INSPECTION

- A. Inspect and review operation of new split air conditioning systems. Inspect for leaks, put systems into operation and test equipment performance. Submit complete report including ambient temperatures, suction and discharge, superheat, unloading pressure, running amperage, and check out low ambient controls.
- B. Contractor shall provide complete installation and maintain all warranties for all units. Contractor shall provide one year parts and maintenance service for all units.

END OF SECTION 238126

SECTION 238239 - UNIT HEATERS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Electric Unit Heaters

1.2 RELATED WORK

- A. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- B. Section 23 05 48 – Vibration and Seismic controls for HVAC Piping and Equipment

1.3 QUALITY ASSURANCE

- A. Electrical heating equipment: Products of manufacturer regularly engaged in production of such units and issuing complete catalog data on such product. Coils shall be UL Listed for zero clearance. Heating elements shall be warranted for two years unless noted otherwise.
- B. All heaters shall be UL listed.

1.4 SUBMITTALS

- A. Submit shop drawings, product data and samples under provisions of Section 013300.
- B. Submit manufacturers' installation instructions under provisions of Section 013300.
- C. Show mechanical and electrical requirements.
- D. Submit schedule of heaters.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data under provisions of Section 013300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Electric Heaters
 - 1. Marley Qmark
 - 2. Markel
 - 3. Brasch
 - 4. Berko
 - 5. Indeeco
 - 6. Vulcan
 - 7. Substitutions: Under provisions of Sections 012500 and 230500.

2.2 ELECTRIC UNIT HEATERS

- A. The heating equipment shall include electric, automatic fan forced air heater suitable for large area heating, as manufactured by QMark Model MUH Series. The heater shall be designed for wall or ceiling mounting with optional mounting bracket. Heaters shall meet all UL, NEC, and OSHA requirements.
- B. 20-gauge die-formed steel housing with stainless steel louvers.
- C. Heating Element: Aluminum-finned, copper clad steel sheath heating element.
- D. Fan and Motor: Fan shall be five bladed aluminum. Fan motor shall be totally enclosed.
- E. Fan Delay Switch: Fan control shall be of bi-metallic, snap-action type and shall activate fan after heating element reaches operating temperature. The fan shall continue to operate after the thermostat is satisfied and until the heating element is cool.
- F. Thermal Cutout: Automatic reset linear thermal cut-out, capillary type, provides protection over entire length of element areas.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install unit heater per manufacturer's instructions.
- B. Refer to drawings for sizes and capacities.

END OF SECTION 238239

SECTION 260000 – ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

- A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.
- B. All equipment and materials proposed for use on this project must be verified and specified as being listed and labeled for their intended application as defined in Article 100 of the NEC.
- C. All electrical work shall be performed, or under direct supervision of, a licensed electrician.
- D. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- E. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- F. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- G. Included in this Contract are electrical connections to equipment provided by the Owner and by the Contractor. Refer to final shop drawings for equipment being furnished under other sections for exact locations of electrical equipment, lighting fixtures and various connections required.
- H. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.
- I. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.3 RELATED WORK

- A. Existing Utilities: Every attempt has been made to indicate existing utilities as accurately as possible from existing drawings, surveys, and data.
- B. Continuity of Service:

1. Do not interrupt or change an electrical service without permission from Owner. Obtain written permission before work is started.

C. Demolition:

1. The Contractor shall submit a demolition plan thirty (30) days prior to the proposed start date for demolition that shall include means and methods and a sketch that shows each fixture and associated bases, conduits, and wiring that will be a part of the demolition for review and approval by the Owner.
2. Perform required demolition work to accomplish new work as described in the Construction Documents.
3. Remove existing lighting fixtures, associated concrete bases per construction documents.
4. Remove abandoned wiring to source of supply.
5. Remove abandoned conduit.
6. Remove abandoned outlets and conduit servicing them.

1.4 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Rules and regulations of Federal, State and local authorities and utility companies in force at time of execution of Contract shall become part of this specification.
- B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.5 LISTING

- A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.
- B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.6 ENCLOSURES

- A. Typical NEMA Enclosures and Usage
 1. NEMA 4X - Outdoors. Rain, snow, sleet, with protection against corrosion
 2. NEMA 1 – Indoors, Incidental contact, falling dirt, liquids and light splashing

1.7 SUBMITTALS

- A. Submit shop drawings for equipment provided under this Division:
 1. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings". However, the expression "Shop Drawings" is generally used throughout specification.
 2. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.

3. Mark general catalog sheets and drawings to indicate specific items submitted.
 4. Include proper identification of equipment by name or number, as indicated in specification and shown on drawings.
 - a. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
 - b. Submit complete record of required components when equipment and items specified include accessories, parts and additional items under one designation.
 - c. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
 - d. Submit shop drawings or product data as soon as practicable after signing Contracts. Submittals must be approved before installation of materials and equipment.
 - e. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
 - f. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 26 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork or electrical raceway layouts.
 - g. Unless specifically requested in Division 26 technical sections, submittals of coordination drawings will be returned without review.
- B. Certificates and Inspections:
1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
- C. Operation and Maintenance Manuals:
1. Upon completion of work but before final acceptance of system, submit to Owner for approval 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
 2. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
 3. Include the following:
 - a. Copies of shop drawings
 - b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, designate applicable type or model

- c. CD ROM's of O&M data with exploded parts lists where available
 - d. Phone numbers and addresses of local parts suppliers and service companies
 - e. Internet/WEB page addresses where applicable
 - f. Factory and field test records
 - g. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
 - h. One copy of each typed panelboard directory (new and existing). Include loads serve, locations, and date.
 - i. Copies of all manufacturer's warranties
 - j. List of manufacturer's local representative
- 4. Instruction shall include complete operating cycle on all apparatus.
 - 5. Furnish O&M manuals and instructions to Owner prior to request for final payment.
- D. Record Documents:
- 1. Use designated set of prints of Contract Documents as prepared by Owner to mark-up for record drawing purposes.

1.8 PRODUCT ALTERNATES AND SUBSTITUTIONS

A. Comply with the following:

- 1. Should the Contractor wish to have products considered other than those specified, he/she must submit those items in accordance with Division 26 Section "Basic Electrical Requirements". Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
- 2. Action for substitutions specified herein will be given only after the receipt of complete data showing manufacturer, model number, performance criteria, physical dimensions and material construction all SPECIFICALLY marked for the individual item. Letter of transmittal with at least 1 copy of all descriptive data shall be submitted to the Owner's office. Data may not be returned; reference addenda for approval to bid.
- 3. Voluntary product substitutions from the Contractor will not be considered without prior approval. Contractor will be required to submit the total savings (anticipated savings) to the Owner.

1.9 QUALITY ASSURANCE

A. Preparation

- 1. Base final installation of materials and equipment on actual dimensions and conditions at the project site. Field measure for materials or equipment requiring exact fit.

B. Workmanship

1. Provide qualified skilled workmen, licensed as required. Perform work in accordance with ANSI/NECA 1-2000. The appearance of the finished work shall be of equal importance with its electrical operation. The Owner may reject work if workmanship and appearance are not satisfactory.

C. Supervision

1. Be responsible for and coordinate the work of all subcontractors working under Division 26.

D. Installation Procedures

1. Confer and cooperate with other trades and coordinate the work in proper relation with theirs.

E. Materials

1. All electrical materials shall be new unless noted otherwise, and acceptable for installation only if labeled or listed as defined in NFPA 70, Article 100, by UL or by a recognized testing laboratory where standards have been established and acceptable to the Authority Having Jurisdiction. Labeled or listed equipment shall be installed in accordance with any instructions or labeling provided with the equipment.
2. Install equipment and materials in accordance with manufacturers' recommendations unless specifically indicated otherwise, or where local codes or regulations take precedence.

1.10 DELIVERY, STORAGE AND HANDLING

A. Comply with Division 01 and individual Division 26 Specification Sections.

- B. Provide for proper storage of all materials and equipment and assume responsibility for losses due to any cause. All storage shall be within the contract limit lines of the building site. Off-site storage will be allowed if permitted under Division 01 requirements. Cover and store all equipment and materials out of elements and off of the ground; any rusted or weather damaged item will not be permitted to be used. Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

C. Acceptance

1. Check and sign for materials to be furnished by others for installation under Division 26 upon delivery. Assume responsibility for the storage and safekeeping of such materials from time of delivery until final acceptance.

1.11 COORDINATION

- A. Inspection: Inspect work preceding or interfacing with work of Division 26 Sections and report any known or observed defects that affect the work to the Owner. Do not proceed with work until defects are corrected.
- B. Existing Utilities: The plans indicate the location, type and sizes of various utilities within the site where known. These utilities are indicated as accurately as possible. If utilities are encountered during construction which are not shown on the drawings, ask for instructions

from the Owner. Any relocation or remodeling required will then be directed. Assume all responsibility for protection of all utilities, shown or not, and repair any damage caused by this construction at no extra charge to the Owner.

1.12 WARRANTIES

- A. All materials and equipment shall be new unless otherwise specified.
- B. Provide a written warranty to the Owner covering the entire electrical work to be free from defective materials, equipment and workmanship for a period of one year unless noted otherwise in individual Sections, after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects at no additional cost to the Owner. Provide certificates (include in O & M Manuals) for such materials and equipment, which have warranties in excess of one year. Include dates of start and end of the warranty and manufacturer's representative name and telephone number.

1.13 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

- A. General: Comply with Division 01.
- B. Temporary Lighting and Power
 - 1. Provide all temporary facilities required to supply construction power and light. Install and maintain facilities in a manner that will protect the public and workmen. Comply with all applicable laws and regulations.
 - 2. Provide covered walkway lights and obstruction lights where required, which shall be kept burning continuously between sunset and sunrise.
 - 3. Upon completion of the work, remove all temporary facilities from the site.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.1 INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacements of components. Connect for ease of disconnection, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.
- E. Waterproofing: Seal all existing openings created by demolition and all new openings at exterior building foundation and wall penetrations so that they are watertight.

F. Cutting and Patching

1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Cutting shall be performed by skilled workmen of trades involved.
2. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

G. Cleaning and Protection

1. Comply with Division 01 and individual requirements of each Division 26 Specification Section.
2. On completion of installation, including fittings and devices, inspect exposed finish. Remove burrs, dirt, paint spots and construction debris.
3. Protect equipment and installations and maintain conditions to ensure that coatings, finished, and cabinets are without damage or deterioration at time of Substantial Completion.

3.2 FINAL OBSERVATION

- A. Comply with Division 01 and individual Division 26 Specification Sections.
- B. Prior to notifying the Owner that the project is ready for the final observation the Contractor must submit the O & M manuals fifteen (15) days prior to the date of final observation or as required in Division 01, and shall verify in writing, that:
 1. All systems are complete.
- C. When the Contractor notifies the Owner that the project is ready for a final observation, the Owner will visit the job site and will prepare a final observation list of all the items on the project that shall be finished or corrected before the project can be accepted.
- D. When the Contractor notifies the Owner that all items on the above final observation list have been completed and corrected, the Owner will visit the project to ascertain that all the items on the final observation list have been corrected and can be accepted.

3.3 PROJECT RECORD DRAWING

- A. Comply with Division 01 and individual Division 26 Specification Sections.
- B. File at job site one copy of Drawings, Specifications, Addenda, approved shop drawings, change orders, field orders, test records, other modifications to Contract Documents.
- C. Do not use Project Record Documents for construction purposes.
- D. Legibly mark with red pencil field changes, such as the following, referenced to permanent and accessible features of the site or building as applicable. Do not permanently conceal any work until required information is recorded.

1. Drawings:
 - a. Locations of concealed utilities.
 - b. Field changes of dimension and detail.
 - c. Changes resulting from change order or field order.
 - d. Details not on original drawings.
 - e. Approved (should be inclusive of all variations of drawings) circuiting changes, or routing changes.
 - f. Manufacturer, model number of equipment actually installed.
 - g. Update all panel schedules with revised circuit numbers and loads.
 2. Shop Drawings
 - a. Changes made after Owner's approval.
- E. At completion of Work transfer all project record document information onto CADD files. Deliver completed Project Record Documents to Owner. Project Record Documents shall include any special system and "project record" shop drawings.

3.4 DEMONSTRATIONS

- A. Comply with Division 01 and individual Division 26 Specification Sections.
- B. Conduct demonstrations only after systems have been through start-up procedures, systems are complete and operating, and operating and maintenance data is complete.
- C. Instruct the Owner's representatives on the proper operation and maintenance of the electrical systems.
- D. Contractor's Representatives:
 1. Contractor's representatives shall have a thorough knowledge of the particular installation.
 2. Manufacturer's representatives shall have a thorough understanding of each particular piece of equipment.
- E. Scheduling: Arrange and schedule demonstration times with Owner.
- F. Location: Conduct demonstrations at project including tours of systems.
- G. Operating and Maintenance Data: Arrange for data to be at demonstrations. Include review of data at demonstrations.
- H. Time Allotment: Provide demonstrations of adequate time periods, except as noted elsewhere, to ensure proper understanding of systems by Owner's representative.

- I. Furnish ladders, tools, etc. as required to provide access to all equipment and controls for demonstrations.

3.5 CONTRACT CLOSEOUT PROCEDURE

- A. Comply with Division 01 and individual Division 26 Specification Sections.
- B. Approval for final payment will not be given until all contract closeout procedures comply with Division 01 Requirements.
- C. Submit Keys for electrical switches, panels, cabinets, enclosures, etc. to the General Contractor.
- D. Remove all materials, scrap, etc. related to the electrical installation. Leave premises in a clean and orderly condition.

END OF SECTION 260000

SECTION 260502 – ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes demolition of power, lighting, communications, and security systems.

1.2 RELATED WORK

- A. Applicable provisions of Division 01 govern work under this Section.

PART 2 MATERIALS AND EQUIPMENT

2.1 MATERIALS AND EQUIPMENT FOR PATCHING AND EXTENDING WORK AS SPECIFIED IN THE INDIVIDUAL SECTIONS

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Verify whether or not PCB ballasts exist in light fixtures which will be disposed of. If PCB light fixture ballasts exist, then follow requirements in **PCB BALLAST HANDLING** and **LAMP AND PCB BALLAST DISPOSAL** required by the local jurisdiction.
- D. Demolition Drawings are based on casual field observation and/or existing record documents. Report discrepancies to the User Agency, Architect/Engineer before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with the User Agency, and Architect/Engineer. Also, if applicable, coordinate utility service outages with the local Utility Company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations and follow the safe working practice requirements of NFPA 70E.
- D. Existing Electrical Service: Maintain existing system in service until temporary system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the User Agency and DFD Field Representative at least 48 hours before partially or completely disabling system. Minimize outage duration. If required, make temporary connections to maintain service in areas adjacent to work area.

- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Obtain permission from the User Agency, and local Authority Having Jurisdiction at least 48 hours before partially or completely disabling system. Minimize outage duration. If required, make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Communication/Data System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the User Agency. If required, make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work to meet all requirements of these specifications.
- B. If certain raceways and boxes are abandoned but not scheduled for removal, those items must be shown on the "As Built Drawings".
- C. Remove, relocate, and extend existing installations to accommodate new construction.
- D. Remove abandoned wiring to source of supply.
- E. Provide revised typed circuit directory in panelboards that have circuits removed.
- F. Remove exposed abandoned conduit and abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- G. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit and wiring servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- H. Disconnect and remove abandoned panelboards and distribution equipment.
- I. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- J. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
 - 1. Repair adjacent construction and finishes damaged during demolition and extension work.
 - 2. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
 - 3. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. This includes the extension of the circuit from the last active device to the next device in the system to be activated.

END OF SECTION 260502

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. PVC - Polyvinyl Chloride
- B. AWG - American Wire & Gauge

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Furnish cables on reels or coils. Each cable and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable shall contain only one continuous cable without splices. Reels shall remain the property of the Owner.
- B. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications : An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing

Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3, Section 3.6.
- B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements:
 1. Comply with NFPA 70 for components and installation.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.8 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

2.1 DESCRIPTION

- A. All low voltage conductors shall be copper only. Aluminum conductor is not allowed.
- B. NEMA WC 70; single copper conductor insulated wire; 600 V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.
 1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THWN, THHW, THW-2, THWN-2.

2.2 MATERIALS

- A. Wire Table: Furnish wire and cable in accordance with the requirements of the wire table below, conforming to the detailed requirements specified herein.
- B. Rated Circuit Voltages: All wire and cable shall have minimum rated circuit voltages in accordance with NEMA WC 70 or equal.

2.3 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. General Cable Corporation.
 2. Southwire Company.
 3. Allied Wire and Cable.

B. Material for Conductors

1. Conductors shall conform to all the applicable requirements of NEMA WC 70 or equal and shall be ICEA stranded or solid, annealed copper meeting requirements of ASTM B 3, soft drawn. Copper conductors may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

C. Size

1. Minimum wire size shall be No. 12 AWG for power and lighting circuits.

D. Stranding

1. Conductor stranding classes cited herein shall be as defined in NEMA WC 70 or equal, as applicable. Lighting conductors No. 10 AWG and smaller shall be solid conductor. No. 8 AWG and larger conductor shall have Class B stranding, or shall meet the requirements of ASTM B 8.

E. Separator Tape

1. Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

F. Insulation

1. Insulation Material: Provide Polyvinyl Chloride (PVC) insulation meeting the requirements of NEMA WC 70 or equal for all THWN cable types.
2. Insulation Thickness: The insulation thickness for each conductor shall be based on its rated circuit voltage.
 - a. Power Cables, 2,000 Volts and Below - The insulation thickness for single conductor cables rated 2,000 volts and below shall be as required by NEMA WC 70 or equal.

G. Jackets

1. All cables shall have jackets meeting the requirements of NEMA WC 70 or equal, as applicable, and as specified herein. Individual conductors of multiple-conductor cable shall be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables shall be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables shall be provided with a common overall jacket, which shall be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.
2. Jacket Material: The jacket shall be one of the materials listed below. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.
 - a. Multiconductor

- 1) Overall jacket - Polyvinyl chloride (PVC) (NEMA WC 70 or approved)
- 2) Conductor jacket - Nylon (UL 1581 or UL recognized equal)
- b. Single conductor
 - 1) Nylon (UL 1581 or UL recognized equal)
3. Jacket Thickness: The minimum thickness of the jackets at any point shall be not less than 80 percent of the respective nominal thicknesses specified below.
 - a. Multiple-Conductor Cables - Thickness of the jackets of the individual conductors of multiple-conductor cables shall be as required by NEMA WC 70 or equal, and shall be in addition to the conductor insulation thickness required by Column B of Table 3-1 of the applicable NEMA publication for the insulation used. Thickness of the outer jackets or sheaths of the assembled multiple-conductor cables shall be as required by NEMA WC 70 or equal.
 - b. Single-Conductor Cables - Single-conductor cables, if nonshielded, shall have a jacket thickness as specified in NEMA WC 70 or equal. If shielded, the jacket thickness shall be in accordance with the requirements of NEMA WC 70 or equal.

2.4 CABLE IDENTIFICATION

A. Color-Coding

1. Single conductor cable shall have a black color insulation or covering.
2. Multiconductor cable shall use Method 4 conductor identification per NEMA WC 57.

B. Cabling

1. Individual conductors of multiple-conductor cables shall be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to NEMA WC 70, except that flat twin cables will not be permitted. Fillers shall be used in the interstices of multiple conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers shall be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape shall consist of a material that is compatible with the other components of the cable and shall be lapped at least 10 percent of its width.

C. Dimensional Tolerance

1. The outside diameters of single-conductor cables and of multiple-conductor cables shall not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

2.5 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1

1. Copper conductor, single insulated wire.

2. Insulation type THHN, THHW, XHHW rated 90°C, 600 V insulation class. Degrees C, 600 V insulation class.
3. Type XHHW for ambient temperature less than 0°C.
4. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.

B. Classes 2 and 3

1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
2. Insulation type XLE, rated 105°C, 300 V insulation class.
3. UL listed for use in space in which circuits will be installed

2.6 CONNECTORS AND SPLICES, AND TERMINALS

A. Manufacturers:

1. Hubbell Power Systems, Inc.
2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division

- B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.7 TERMINATIONS

- A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.8 PLASTIC CABLE TIES

- A. Nylon or approved; locking type; metallic ties not permitted.

2.9 TERMINATIONS

- A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.10 PLASTIC CABLE TIES

- A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

- A. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

- B. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- D. Identify and color-code conductors and cables according to Section 260553 – Electrical Systems Identification.
- E. Install conductors in a raceway system.
- F. Install conductors only after:
 - 1. Building interior is enclosed and weather tight
 - 2. Mechanical work likely to damage conductors has been completed
 - 3. Raceway installation is complete and supported
- G. Pull conductors into raceway at same time.
- H. Neatly train and lace conductors inside boxes, equipment, and panelboards.
- I. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- J. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- K. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- M. Wiring at Outlets: Install conductor at each outlet, with minimum 12" of slack.
- N. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Minimum conductor sizes shall be as follows:
- D. No. 12 AWG – Branch circuits of any kind
- E. Minimum conductor sizes shall be as follows:
 - 1. No. 12 AWG – Branch circuits of any kind.
 - 2. No. 16 AWG – Remote control and signal systems, fire alarm system.

F. Branch wiring length limitations:

1. 208Y/120 V circuits over 100 ft in length: Increase wire size one size for each 100 ft of length. Increase conduit size as required.
2. 480Y/277 V circuits over 150 ft in length: Increase wire size one size for each 150 ft of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHW, THWN, XHHW, rated 75°C for wet locations, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHW, THWN, XHHW, rated 75°C for wet locations, single conductors in raceway.
- C. Exposed Branch Circuits, Including in Crawl Spaces: Type THHN, THW-2, THWN-2, XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.
- D. Motor Circuit Branch Wiring and Associated Control Wiring: Type THHN, rated 90°C for dry and damp locations, single conductors in raceway, Metal-clad cable, Type MC, stranded. Limit the length of the MC cable whip to maximum length of 6-feet.
- E. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.
- F. Metal-clad cable, Type MC, use for the following:
 1. For Mechanical Connections only.
 2. Maximum length shall be limited to 6-feet.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.
- H. Feeders from VFD's to motors shall be "VFD" type Belden Classic Symmetrical design with 3 symmetrical bare grounds or equivalent in metal conduit. P/N series 295XX.

3.4 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Sizing - #16 AWG minimum.
- B. Installation:
 1. All conductors shall be installed in conduits.
 2. Use suitable cable fittings and connectors.

3.5 CONNECTORS, SPLICES, AND TERMINALS

- A. Connectors:

1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.
3. Use pre-insulated "twist-on" connectors with integral spring for splices and taps of #10 AWG conductors and smaller.
4. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Splices:

1. Splice wires and cable only in accessible locations such as within junction boxes.
2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
3. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
4. Plastic snap-on splice insulators are not allowed.
5. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Terminals:

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
3. Train wires to eliminate fanning of stands, crimp with proper tool and die.
4. Torque screw termination per manufacturer's recommended values.

3.6 CABLE TIES

- A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.7 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

- 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

3.8 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
- B. Test 600 volt conductors and cables per NETA requirement.
 - 1. Inspection and Test Procedures: Comply with NETA.
 - a. Visual and Mechanical Inspection:
 - 1) Compare cable data with drawing and specifications.
 - 2) Inspect exposed sections of cables for physical damage.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.
 - 4) Inspect compression-applied connectors for correct cable match and indentation.
 - 5) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.
 - 6) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.
 - 7) Inspect for correct identification and arrangements.
 - 8) Inspect jacket and insulation condition.
 - b. Electrical Tests:
 - 1) Perform insulation-resistance test using megohm meter. Applied potential to be 1000 VDC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.
 - 2) Perform continuity tests to insure correct cable connection.

- c. Test Values:
 - 1) Insulation-resistance values should not be less than 50 megohms.
- C. Interpret test results in writing and submit to Engineer.
- D. Replace conductors and cables that are found defective, at no expense to Owner
- E. Infrared Scanning:
 - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- G. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Provide all necessary grounding in accordance with the latest edition of the National Electrical Code, and as called for on the drawings or described herein.
- B. The following shall be solidly grounded to the ground system:
 - 1. Raceway systems.
 - 2. Motor frames.
 - 3. Equipment enclosures.
 - 4. Panelboards.
 - 5. Switchboards

1.2 SUBMITTALS

- A. Submit shop drawings of all grounding equipment in accordance with Section 013300.

1.3 REFERENCE

- A. All work under this section shall be subject to the requirements of Section 260000 ELECTRICAL, and any applicable conditions specified for the entire work.

PART 2 PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. Grounding conductors shall be bare copper, except where installed in conduit with associated phase conductors. Insulated conductors shall be furnished with 600 volt insulation as specified for wires and cable in Section 260519 All insulated grounding conductors shall have green colored insulation. Bare conductors shall be ASTM B8, soft drawn.

2.2 GROUNDING CONNECTORS

- A. Provide all necessary lugs and connectors for grounding conductors. Grounding connections above grade shall be made with bolted solderless connectors in compliance with UL 467.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Furnish and install an equipment grounding conductor run with the circuit conductors for all receptacle and equipment circuits, and connected to the receptacle or equipment.

- B. All flexible metal conduits shall contain ground wire sized in accordance with the NEC.
- C. Provide ground jumpers on conduit expansion fittings.

3.2 GROUNDING AT SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- 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.
 - 10. 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.
 - 11. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 - 12. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
 - 13. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a

nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

14. Metallic Fences: Comply with requirements of IEEE C2.
15. Grounding Conductor: Bare copper, not less than No. 8 AWG.
16. Exterior metallic handrails.

3.4 INSTALLATION

- A. 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.
- B. Ground Rods: Drive rods until tops are 2 inches 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.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole and shall be at least 12 inches deep, with cover.
 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.
 2. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 3. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 4. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 5. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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.
 4. 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.
- E. 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 apart.

3.5 FIELD QUALITY CONTROL

- A. Engage a qualified testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
 - 4. Pad-Mounted Equipment: 5 ohms.
 - 5. Handhole Grounds: 10 ohms.
 - 6. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260526 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section “Electrical General Provisions”
 - 2. Division 26 Section “Raceway and Boxes for Electrical Systems”
 - 3. Division 26 Section “Low Voltage Electrical Power Conductors and Cables”

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze hangers. Include Product Data for components.
 2. Steel slotted channel systems. Include Product Data for components.
 3. Nonmetallic slotted channel systems. Include Product Data for components.
 4. Equipment supports.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Welding certificates.
- 1.7 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.
- 1.8 COORDINATION
- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- 1.9 PERFORMANCE REQUIREMENTS
- A. Delegated design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Thomas & Betts Corporation.
 - d. Unistrut; Tyco International, Ltd.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Hilti Inc.
 - 3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacing less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 specifications "Metal Fabrications" for site fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

END OF SECTION 260529

SECTION 260533 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Division 26 Section “Common Work Results for Electrical”
2. Division 26 Section “Hangers and Supports for Electrical Systems”
3. Division 26 Section “Identification for Electrical Systems”

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. NBR: Acrylonitrile-butadiene rubber.
- G. RMC: Rigid metal conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Samples for Initial Selection: For wireways, and surface raceways with factory-applied texture and color finishes.
 - 1. Size: 1 foot
- D. Samples for Verification: For each type of exposed finish required for wireways, and surface raceways, prepared on Samples of size indicated below.
 - 1. Size: 1 foot

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer and testing agency.
- B. Source quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. General Description: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thickness) required for each service. Where types and grades are not indicated, provide proper selection determined by Contractor to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Generic names for some types of raceways are shown in parenthesis and are used interchangeably in these specifications and on drawings.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 2. Anixter Brothers, Inc.
 - 3. O-Z Gedney; a unit of General Signal.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. Electrical Metallic Tubing (EMT): Hot galvanized steel exterior with organic corrosion resistant interior coating and be produced in accordance with ANSI C80.3 and UL 797.
- E. Liquidtight Flexible Metal Conduit (LFMC): Conduit having an exterior liquid tight, nonmetallic (PVC), sunlight-resistant jacket over an interior flexible metal core constructed from a continuous, interlocked, double-wrapped, galvanized (both interior and exterior) strip of steel. LFMC conduit to be produced in accordance with UL 360.
- F. Rigid Metal Conduit (RMC): Hot dipped, galvanized, threaded type steel conduit produced in accordance with UL Standard #6 and ANSI C80.1. Threads shall be hot galvanized after cutting
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL CONDUITS, TUBING, AND FITTINGS

2.3 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. General Description: Provide nonmetallic conduit, ducts and fittings of types, grades, sizes and weights (wall thickness) required for each service. Where types and grades are not indicated, provide proper selection determined by Contractor to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Generic names for some types of raceways are shown in parenthesis and are used interchangeably in these specifications and on drawings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
 2. Electri-Flex Co.
 3. Hubbell, Inc.; Raco, Inc.
- C. Rigid Nonmetallic Conduit (RNC): Conduit constructed of polyvinyl chloride (PVC) suitable for direct burial or above ground use and conforming with NEMA TC 2 and UL 651 unless otherwise indicated. Conduit shall be schedule 40 or schedule 80.
1. Schedule 40 PVC Conduit: Normal duty in exposed or concealed applications above ground or for underground installation without concrete encasement. Made of polyvinyl chloride (EPC-40-PVC).
 2. Schedule 80 PVC Conduit: Heavy duty applications above or below ground that are subject to severe physical abuse. Made of polyvinyl chloride (EPC-80-PVC).

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. General Description: Provide metal wireways of types, grades, sizes and number of channels required for each service.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 2. Hoffman.
 3. Thomas and Betts Corporation.
- C. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Sheet metal, Screw-cover type, Flanged-and-gasketed type or as indicated on drawings.
- F. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE METAL RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect, Prime coated, ready for field painting.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Thomas & Betts Corporation.
 - 2. Walker Systems, Inc.; Wiremold Company (The).
 - 3. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman.
 - 2. O-Z/Gedney; a unit of General Signal.
 - 3. Thomas & Betts Corporation.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized steel with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- K. Gangable boxes are allowed.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio frequency-resisting paint.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Quazite PG style tier 15 or greater: Hubbell Power Systems, Inc.
 - b. Synertech Moulded Products.
 - c. Standard: Comply with SCTE 77.

2. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "LIGHTING" OR "TELECOM."
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Quazite PG style tier 15 or greater: Hubbell Power Systems, Inc.
 - b. Synertech Moulded Products.
 - c. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "LIGHTING" OR "TELECOM."
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 GENERAL EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC, EMT.
 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4, 4X.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC, Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet handling units.
 - c. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120°F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits.
- B. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Complete raceway installation before starting conductor installation.
- E. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches of enclosures to which attached.
- J. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete.
 - 5. Change from RNC to GRC before rising above floor.
- K. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits 2-inch (trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Surface Raceways:
 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with 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 according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- X. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30°F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100°F and that has straight-run length that exceeds 100 feet
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125°F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155F° temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125°F temperature change.
 - d. Attics: 135°F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set metal floor boxes level and flush with finished floor surface.

3.3 BOX, ENCLOSURE AND CABINET INSTALLATION

A. Examine surfaces to receive boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Install boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

C. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

D. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

E. Set metal floor boxes level and flush with finished floor surface.

F. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260544- SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAY AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
- B. 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. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
- C. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 1. Pressure Plates: Carbon steel.
 - 2. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
- B. 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. Presealed Systems.
 - 2. Advance Products & Systems, Inc.
 - 3. Metraflex Co.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: 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 that are not fire rated.
 - 2. Sealant VOC content shall be calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant 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. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings: 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. This Section Includes:

1. Identification for raceways and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

B. Related Sections include the following:

1. Division 26 Section "Common Work Results for Electrical"
2. Division 26 Section "Raceway and Boxes for Electrical Systems"
3. Division 26 Section "Low Voltage Electrical Power Conductors and Cables"

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes and standards. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Legend: Indicate system or service and voltage, if applicable.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive, vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

- C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.
- D. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, preprinted, celluloseacetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legend:
 - 1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.4 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process.
 - 1. Minimum letter height shall be 3/8 inch (10 mm).
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- E. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength: 50 lb (22.6 kg), minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
 - 1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coats over a primer.
 - 1) Primer: Exterior concrete and masonry primer.
 - 2) Finish Coats: Exterior semi-gloss acrylic enamel.
 - 2. Exterior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coats over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Exterior semi-gloss acrylic enamel.
 - 3. Exterior Ferrous Metal:
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coats over a primer.
 - 1) Primer: Exterior ferrous-metal primer.
 - 2) Finish Coats: Exterior semi-gloss alkyd enamel.
 - 4. Exterior Zinc-Coated Metal (except Raceways):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coats over a primer.
 - 1) Primer: Exterior zinc-coated metal primer.

- 2) Finish Coats: Exterior semi-gloss alkyd enamel.
5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coats over a primer.
 - 1) Primer: Interior concrete and masonry primer.
 - 2) Finish Coats: Interior semi-gloss alkyd enamel.
6. Interior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coats over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.7 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.
- F. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- G. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 2. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.

Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

2.8 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.9 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

- B. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

- C. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
4. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, [continuous-printed on one side with the inscription of the utility,]compounded for direct-burial service.
5. Overall Thickness: 8 mils (0.2 mm).
6. Foil Core Thickness: 0.35 mil (0.00889 mm).
7. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).

8. 3-Inch (75-mm) Tensile According to ASTM D 882: 300 lbf (1334 N), and 12,500 psi (86.1 MPa).

2.10 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 1. Engraved legend with [black letters on white face] <Insert colors>.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.11 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.12 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.

3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legend:

1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.13 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.14 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm)

2.15 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F ((23 deg C)), According to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.16 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 30-foot (10-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
 - b. Colors for 240/120-V Circuits:
 - 1) Phase A: Black.

- 2) Phase B: Red.
- 3) Phase C: Blue.
- c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
- d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesivebacked phase tags, and a separate tag with the circuit designation.
- F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels with the conductor Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
- J. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- K. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- L. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 unless otherwise

indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting
 - 1. Identify system voltage with black letters on an orange background.
 - 2. Apply to exterior of door, cover, or other access.
- N. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual.
- P. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, Stenciled legend 4 inches (100 mm) high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - e. Enclosed switches.

- f. Enclosed circuit breakers.
- g. Variable-speed controllers.
- h. Push-button stations.
- i. Remote-controlled switches, dimmer modules, and control devices.
- j. Battery racks.
- k. Monitoring and control equipment.
- l. UPS equipment

END OF SECTION 260553

SECTION 260573 - SHORT CIRCUIT/COORDINATION STUDY AND ARC FLASH HAZARD STUDY

PART 1 GENERAL

1.1 SCOPE

- A. The electrical contractor shall retain the services of an independent third party firm to perform a short circuit/coordination study and arc flash hazard study as described herein.
- B. The studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.
- C. The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency / standby sources, down to and including the smallest circuit breaker in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- D. The firm should be currently involved in high- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Maryland. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Design Engineer for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.
- E. The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- F. The study and assessment shall be performed based on SKM's Dapper, Captor and PowerTool software.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 26 24 16 – Panelboards

1.3 QUALITY ASSURANCE

- A. One- Reference standards listed in the IEEE "Buff Book", latest edition.

1.4 DATA COLLECTION FOR THE STUDY

- A. The contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the contractor with a listing of the required data immediately after award of the contract.
- B. The contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

1.5 SUBMITTALS

A. THIRD PARTY QUALIFICATIONS

1. Submit qualifications of individual(s) who will perform the work to Design Engineer for approval prior to commencement of the studies.

B. DRAFT REPORT

1. Submit a draft of the study to Design Engineer for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

C. FINAL STUDY REPORT

1. Provide studies in conjunction with equipment submittals to verify equipment ratings required.
2. The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted. Provide two (2) copies in PDF format of the study, so that it can be more easily stored and shared. Also, provide 2 copies (on CD) of the report in MS word, and 2 copies (on CD) of the one-line diagram in CAD format.

D. The report shall include the following sections:

1. Overview
2. Short Circuit Study
 - a. SC-1 Purpose
 - b. SC-2 Explanation of Data
 - c. SC-3 Assumptions
 - d. SC-4 Analysis of Results
 - e. SC-5 Recommendations
 - f. SC-6 DAPPER Fault Analysis Input Report
3. Protective Device Coordination Study
 - a. PDC-1 Purpose
 - b. PDC-2 Explanation of Data
 - c. PDC-3 Assumptions
 - d. PDC-4 Analysis of Results
 - e. PDC-5 Recommendations (Including NEC 700-27 Requirement)
 - f. PDC-6 CAPTOR Results

- g. PDC-7 Example Drawings
4. Arc Flash Study
- a. ARC-1 Purpose
 - b. ARC-2 Explanation of Data
 - c. ARC-3 Assumptions
 - d. ARC-4 Analysis of Results
 - e. ARC-5 Recommendations
 - f. ARC-6 SKM Arc Flash Evaluation Report
5. Prioritized Recommendations and Conclusions
- a. Appendices
 - b. APP-1 DAPPER One-line Diagrams
 - c. APP-2 AutoCAD One-line Diagrams
 - d. APP-3 SKM Protective Device Summaries
 - e. APP-4 Reference Data
 - f. APP-5 Sample Work Permit Form
 - g. APP-6 Copy of Warning Labels, including study date
 - h. The above sections shall include the following items in detail:
 - 1) Obtain available fault current from the local utility company.
 - 2) Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.
 - 3) Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
 - 4) Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
 - 5) Arc flash values for two normal cases to define the highest values (low short circuit and high short circuit).
 - 6) Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.

- 7) IEEE standard one-line diagram with equipment evaluation and circuit breaker setting forms that clearly define the system data and are easy to interpret.
- 8) Recommendations to reduce the arc flash incident energy in all areas that require class2 and higher PPE.
- 9) Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
- 10) The contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24" x 36" (minimum) Styrofoam backboard. This one one-line diagram shall be mounted in each electrical room.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 SHORT CIRCUIT AND COORDINATION STUDY

- A. The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
- B. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
- C. Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- D. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer

withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

- E. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- F. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.
- G. Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- H. Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not properly rated for fault conditions.
- I. Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.
- J. When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- K. Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- L. For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

3.2 FIELD SETTINGS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash hazard study.
- B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.3 ARC FLASH HAZARD STUDY

- A. As part of the short circuit and coordination study, arc flash hazard study shall be included. The study shall include the following:
1. Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
 2. Calculations to conform to National Fire Protection Association (NFPA) 70E – 2003 calculation standards. All incident energy units shall be calculated in calories per square centimeter.
 3. Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E-2003 for each piece of electrical gear.
- B. Electrical Contractor shall provide labeling as required by OSHA based upon the results of the arc flash hazard study. At a minimum, the labeling shall contain the following information: PPE level, Flash Hazard Boundaries, Flash Protection Boundary, and Shock Hazard Boundaries such as Limited Approach Boundary, Restricted Approach Boundary, Prohibited Approach Boundary, and study date."

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

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. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching and dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. Digital timer light switches.
7. High-bay occupancy sensors.
8. Extreme temperature occupancy sensors.
9. Outdoor motion sensors.
10. Lighting contactors.
11. Emergency shunt relays.

- B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

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

- B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which equipment will be attached.
 - 3. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Control modules.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 TIME SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic, Inc.; ET2000 Series or a comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Invensys Controls.
 3. Leviton Manufacturing Co., Inc.
 4. NSi Industries LLC.
 5. TE Connectivity Ltd.
- B. Electronic Time Switches: Programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
 2. Contact Configuration: SPST.
 3. Contact Rating: 10-A electronic ballast (LED) 120/277-V ac
 4. Programs: Ninety-six (96) on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
 5. Programs: Ninety-six (96) on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 6. Programs: One to four channels; each channel is individually programmable with 96 on-off set points total on a 24-hour schedule.
 7. Programs: One to four channels; each channel is individually programmable with 96 on-off set points total on a 24-hour schedule with a skip-a-day weekly schedule.
 8. Programs: One to four channels; each channel is individually programmable with 96 on-off set points total on a 24-hour schedule, allowing different set points for each day of the week.
 9. Programs: One to four channels; each channel is individually programmable with 96 on-off operations per week total and an annual holiday schedule that overrides the weekly operation on holidays.
 10. Programs: One to four channels; each channel is individually programmable with 96 on-off operations per week total, and 50 annual holiday schedules that override the weekly operation on holidays.
 11. Programs: and an annual holiday schedule that overrides the weekly operation on holidays.
 12. Astronomic Time: All
 13. Astronomic Time, ET2800 Series: 1 4 channels.
 14. Automatic daylight savings time changeover.

15. Super Capacitor Backup: Not less than 100 hours reserve, to maintain schedules and time clock.

C. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration:
 - a. Model ET2x05 Series: SPST.
 - b. Model ET2x25 Series: Pulse ON, Pulse OFF.
 - c. Model ET2x45 Series: Pulse ON, Pulse OFF, Two SPST.
3. Contact Rating: 20-A ballast load, 120-/240-V ac.
4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
5. Astronomic Electronic Control ET2800 Series will automatically adjust for DUSK/DAWN settings.
6. Seven-Day Program: Uniquely programmable for each weekday and holidays.
7. Skip-a-day mode.
8. Super Capacitor to keep time during power failures, minimum of 100 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic, Inc.; EK Series Fix Mount Electronic Photo Controls and EK Series, ELC Series, LED Series Twistlock Electronic Photo Controls or a comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Leviton Manufacturing Co., Inc.
 3. NSi Industries LLC.
 4. TE Connectivity Ltd.
- B. Description: Fixed Mount Electronic Relay Based, SPST, with a non-drift silicon sensor and IR filter for human eye response. Rated for 1,000-W tungsten, or 1,800-VA ballast and 6-A electronic ballast/LED driver rating, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 3. Time Delay: Two- to five-seconds, to ANSI standard, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.

5. Mounting: 1/2-inch (13-mm) threaded male conduit. Fixed Mount meets or exceeds ANSI C136.24, UL 773A, and CSA Requirements with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
 6. Failure Mode: Luminaire stays ON.
- C. Description: Twistlock Electronic Photo Control with a non-drift silicon sensor and IR filter for human eye response. Rated for 1,000-W Tungsten, 1,800-VA ballast, and 2-A through 8-A electronic ballast/LED driver, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, and meets or exceeds ANSI C136.10-2010, UL 773, and CSA requirements.
 6. Failure Mode: Luminaire stays ON.
- D. Description: Relay Based, with SPST dry contacts rated for 1000-W tungsten or 1800-VA ballast, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 fc (16.14 lux) Instant ON and 2.25 fc (24.22 lux) time delayed OFF.
 3. Time Delay: Two- to five-seconds per ANSI guidelines, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with NEMA C136.10, with base.
 6. Failure Mode: Luminaire stays ON.
- E. Description: Solid state; one set of NO dry contacts rated for 24 V dc at 1 A, to operate connected load, complying with UL 773, and compatible with power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 fc (16.14 lux) Instant ON and 2.25 fc (24.22 lux) time delayed OFF.
 3. Time Delay: Two- to five-seconds per ANSI guidelines, to prevent false operation.
 4. Mounting: 1/2-inch (13-mm) threaded male conduit.

5. Failure Mode: Luminaire stays ON.
6. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - a. LED status lights to indicate load status.
 - b. Plenum rated.
7. Power Pack: Digital controller capable of accepting four RJ45 inputs with two outputs rated for 20-A incandescent or LED load at 120- and 277-V ac, for at 120- and 277-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 - a. With integral current monitoring
 - b. Compatible with digital addressable lighting interface.
 - c. Plenum rated.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. Watt Stopper.
- B. System Description: System operates indoor lighting.
- C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present.
 - b. When significant daylight is present (target level).
 - c. System programming is done with two hand-held, remote-control tools.
- D. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with **[integrated]** power pack, that detects changes in indoor lighting levels that are perceived by the eye.
- E. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, that detects changes in indoor lighting levels that are perceived by the eye.
- F. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
4. Sensor Output: Digital signal compatible with power pack.
5. Sensor type: Open loop.
6. Zone: Single.
7. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - a. LED status lights to indicate load status.
 - b. Plenum rated.
8. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 20-A incandescent LED load at 120- and 277-V ac, for 16-A or LED at 120- and 277-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
 - a. With integral current monitoring
 - b. Compatible with digital addressable lighting interface.
 - c. Plenum rated.
9. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
10. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1,000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
11. Skylight Sensors Light-Level Monitoring Range: 1,000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
12. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
13. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
14. Test Mode: User selectable, overriding programmed time delay to allow settings check.
15. Control Load Status: User selectable to confirm that load wiring is correct.
16. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.

3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. Watt Stopper.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **separate** power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).
- E. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-Atungsten at 120-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
1. LED status lights to indicate load status.
 2. Plenum rated.
- F. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 20-A incandescent or LED load at 120- and 277-V ac, for 16-A LED at 120- and 277-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
1. With integral current monitoring
 - a. Compatible with digital addressable lighting interface.
 - 1) Plenum rated.

2.5 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic, Inc.; **IOS-CMP** Series and **IOS-HB** Series or a comparable product by one of the following:
1. Cooper Industries, Inc.

2. Hubbell Building Automation, Inc.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. Lutron Electronics Co., Inc.
 5. Watt Stopper.
- B. General Requirements for Sensors:
1. Ceiling-mounted, relay based indoor occupancy and vacancy sensors.
 2. Dual technology.
 3. Separate IOS-CMP-LV and IOS-CMP-DT-LV models only, power pack model number IOS-PP24.
 4. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 5. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range.
 - 1) Models IOS-CMP-DT-LV, IOS-CMP-DT-U: 5 seconds to 30 minutes.
 - 2) Models IOS-CMP-LV, IOS-CMP-U, IOS-HB-U: 15 seconds to 30 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 5 seconds to 30 minutes.
 6. Sensor Output: Sensor is powered from the power pack.
 7. Power: Line voltage.
 8. Power Pack:
 - a. Models IOS-CMP-DT-LV, IOS-CMP-LV: Dry contacts rated for 20-A inductive ballast, 15-A tungsten, and for 1 horsepower at 120/240-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - b. Models IOS-CMP-U, IOS-HB-U: Dry contacts rated for 800-VA at 120-V ac, 1,600-VA at 277-V ac electronic ballast/LED, or 800-W at 120-V ac tungsten/incandescent.
 - c. Model IOS-CMP-DT-U: Dry contacts rated for 5-A electronic ballast/LED load at 120- and 277-V ac, or 800-W incandescent at 120-V ac.
 9. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.

- b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 10. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 11. Bypass Switch: Override the "on" function in case of sensor failure.
 - 12. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. Dual-Technology Type: **Ceiling** mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
- 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 360-degree pattern centered on the sensor over an area of 1,600 square feet (148.6 square meters) for Dual Technology.

2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic, Inc.; IOS-DOV, IOS-DSR, IOS-DDR, OS-DPBIF, IOS-DSIF, and IOS-DPBIF2 (Vacancy Only), or a comparable product by one of the following:
- 1. Cooper Industries, Inc.
 - 2. Hubbell Building Automation, Inc.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 5. Lutron Electronics Co., Inc.
 - 6. Sensor Switch, Inc.
 - 7. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.
- 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 15 seconds to 30 minutes.
 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view.
 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 3. Switch Type: field-selectable automatic "on," or manual "on," automatic "off."
 4. Capable of controlling load in three-way application.
 5. Voltage: Dual voltage - 120 and 277 V.
 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 2.8 fc (30 lux) to daylight. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 8. Concealed, "off" time-delay selector at 15 seconds and 5, 10, and 20 minutes.
 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
 10. Colorper architect.
 11. Faceplate: Color matched to switch.
- D. Wall-Switch Sensor Tag WS2:
1. Standard Range: 180-degree field of view, with a minimum coverage area of 1,200 sq. ft. (111.5 sq. m). Models IOS-DPBIF2, IOS-DPBIF, IOS-DSIF have a standard range of 150-degree field of view, with a minimum coverage area of 980 sq. ft. (91.0 sq. m).
 2. Sensing Technology: PIR.
 3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
 4. Capable of controlling load in three-way application.
 5. Voltage: Dual voltage, 120 and 277
 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: per architect.
11. Faceplate: Color matched to switch.

2.7 DIGITAL TIMER LIGHT SWITCH

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic, Inc.; EI600 Series, EI500 Series, ST01 Series, and EJ600 Series, or a comparable product by one of the following:
 1. Cooper Industries, Inc.
 2. Leviton Manufacturing Co., Inc.
 3. Lutron.
- B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, LCD display, with selectable time interval in 1-minute increments.
 1. EI600 Ratings: 12-A resistive at 120-V ac for incandescent lighting, 6-A at 208/277-V ac incandescent lighting, 20-A resistive at 120/277-V ac, 16-amps at 120/277-V ac for **LED**, 1 horsepower at 120-V ac, and 2 horsepower at 240-V ac.
 2. EJ600 Ratings: 12-A resistive, 500-VA ballast, 15-A incandescent, and 1/2 horsepower at 120-V ac.
 3. ST01 Ratings: 15-A resistive at 120/277-V ac, 8-A inductive ballast/fluorescent at 120-V ac, 4-A inductive ballast/fluorescent at 208/277-V ac, 1 horsepower at 120-V ac, and 2 horsepower at 240-V ac.
 4. EI500 Ratings: 15-A resistive/general purpose at 120-V ac, 1000-VA inductive ballast/fluorescent, 500-VA electronic ballast/LED, 1000-W incandescent, and 1/4 horsepower at 125-V ac.
 5. Voltage: Dual voltage - 120 and 277 V.
 6. Color: per architect.
 7. Faceplate: Color matched to switch.

2.8 HIGH-BAY OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic, Inc.; IOS-HB-U or a comparable product by one of the following:
 1. Hubbell Building Automation, Inc.
- B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 15 seconds to 30 minutes.
 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 4. Power: Line voltage.
 5. Power Pack: Dry contacts rated for 800-VA at 120-V ac, 1,600-VA at 277-V ac electronic ballast/LED, or 800-W at 120-V ac tungsten.
 6. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
 7. Mounting: Threaded pipe.
 8. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 9. Detector Technology: PIR.
- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m). Detect occupancy anywhere within a 360-degree pattern centered on the sensor over an area of 1,200 square feet (111.5 square meters) 2,800 square feet (260.1 square meters) for PIR Technology.
- D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.9 EXTREME-TEMPERATURE OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Sensor Switch, Inc.
- B. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
 2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Operating Ambient Conditions: From minus 40 to plus 125 deg F (minus 40 to plus 52 deg C).
 4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 5. Power Pack: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

6. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc (21.5 to 108 lux); keep lighting off when selected lighting level is present.
- C. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. (139 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (High Bay): Detect occupancy within 25 feet (7.6 m) when mounted on a 25-foot- (7.6-m-) high ceiling.

2.10 OUTDOOR MOTION SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. Watt Stopper.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Dual-technology (PIR and infrared) type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
 3. Switch Rating:
 - a. Luminaire-Mounted Sensor: 500-VA fluorescent/LED.
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 horsepower at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 4. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off." With bypass switch to override the "on" function in case of sensor failure.

5. Voltage: Dual voltage, 120- and 277-V type.
6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
 - b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.
 - c. 2000 sq ft.
7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
9. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

2.11 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 3. Eaton.
 4. General Electric Company.
 5. Square D.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- C. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

1. Monitoring: On-off status, coordinate with mechanical.
2. Control: On-off operation, coordinate with mechanical.

2.12 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Lighting Control and Design.
 2. Watt Stopper.
- B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
 1. Coil Rating: 120V.

2.13 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Retain "Testing Agency," "Manufacturer's Field Service," and "Perform the following tests and inspections" paragraphs below to identify who shall perform tests and inspections. If retaining second option in "Testing Agency" Paragraph or if retaining "Manufacturer's Field Service" or "Perform the following tests and inspections" Paragraph, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.
- B. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Lighting control devices will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose
 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 261839 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 260000, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of motor starter work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of motor starters required for the project include, but are not limited to, the following:
 - 1. Individual motor starters.
 - 2. Combination motor starters.
 - 3. Manual motor starters.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NEMA ICS 2 Industrial Control Devices, Controllers, and Assemblies.
 - 2. NEMA KS 1 Enclosed Switches.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Allen-Bradley.
 - 3. General Electric Company.
 - 4. Square D Company.
- B. UL Listing: Motor starters shall conform to all applicable UL Standards and shall be UL-listed.

1.5 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of individual and combination motor starters with construction, ratings, voltage, poles, and all associated accessories clearly indicated.

2. Cut sheets of manual motor starters with ratings, voltage, poles, and all associated accessories clearly indicated.
3. Cut sheets of manual motor disconnect switches with ratings, voltage, poles, and all associated accessories clearly indicated.
4. Additional information as required in Section 26 00 01, "Electrical General Provisions".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Store motor starters in a clean, dry space. Maintain factory-wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle motor starters carefully to avoid damage to material components, enclosure and finish.

PART 2 PRODUCTS

2.1 INDIVIDUAL MOTOR STARTERS:

- A. General: Individual motor starters shall consist of an integrally mounted, magnetic, full-voltage, non-reversing (FVNR), 2-speed - 1-winding (2S-1W), or 2-speed - 2-winding (2S-2W) starter in a heavy-duty type, dead front, sheet steel enclosure and shall be surface-mounted. Size and number of poles shall be as shown and required by equipment served. All starters shall be constructed and tested in accordance with the latest NEMA standards and shall be NEMA standard sizes. IEC sizes are not acceptable. All starters shall contain 480V – 120V control transformer.
- B. Contacts: Magnetic starter contacts shall be solid silver cadmium oxide alloy and shall not require any filing, dressing or cleaning throughout the life of the starter.
- C. Operating Coils: Operating coils shall be 120 volts and shall be pressure molded and designed so that accidental exposure to excessive voltage up to 480 volts will not damage the coil. The starter design shall also be such that when a coil fails due to an overvoltage condition, the starter shall definitely open and shall not freeze in the closed position.
- D. Overload Relays: All starters shall have user selectable class 10/20/30 solid state overload relays. Overload relays shall have visual trip indication, be ambient insensitive within an operating temperature range to minus 20 and to plus 70 degrees Celsius. They shall provide built in thermal memory to prevent hot motor restarts. Relays shall provide protection against phase current loss, and phase current unbalance, adjustable from 20 to 50 percent for all 3 phases. Relay shall have adjustable full load current dial. They shall have a reset mechanism that resets on the upstroke only.
- E. Pilot Lights: Provide red RUNNING pilot lights for all motor starters. Furnish additional pilot lights for motor starters as shown. Provide amber FAST and green SLOW pilot lights for all two speed starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter and shall not be wired across the operating coil. Pilot lights shall be LED type.
- F. Controls: Provide starters with HAND-OFF-AUTOMATIC switches, or START-STOP pushbuttons as shown or required. Provide for FAST-SLOW speed selection from HVAC control system in the automatic position for all two speed starters. Provide two-speed

starters with FAST-SLOW selector switches for manual speed selection in the HAND position. All two speed starters shall have deceleration relays between fast and slow speeds. Coordinate motor starter controls with the requirements of Division 15. Motor starter controls shall be mounted in the starter enclosure cover.

- G. Control Power: A single-phase control power transformer shall be included integrally with each starter for 120 volt control power. The primary shall be connected to the line side of the motor starter and shall have both legs fused; the secondary shall have one leg fused and one leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
- H. Auxiliary Contacts: Each starter shall have a minimum of one normally open and one normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock". Provide additional contacts if required for control, interlock, and monitoring. In addition, it shall be possible to field-install one or more additional auxiliary contacts without removing existing wiring or removing the starter from its enclosure.
- I. Unit Wiring: Unit shall be completely prewired to terminals to eliminate any interior field wiring except for:
 - 1. Connection of power supply conductors to switch line side terminals.
 - 2. Motor leads to the starter load side terminals.
 - 3. Control conductors to holding coil terminals.
- J. Enclosures: All motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.

2.2 COMBINATION MOTOR STARTERS:

- A. General: Combination motor starters shall consist of an integrally mounted magnetic starter and a breaker type disconnect switch in a heavy-duty type, dead front, sheet steel NEMA 1 enclosure, surface-mounted. Size and number of poles shall be as shown and required by equipment served. Combination motor starters shall be as specified for individual motor starters in Paragraph 2.1, except as modified herein.
- B. Unit Wiring: Unit shall be completely prewired to terminals to eliminate any interior field wiring except for:
 - 1. Connection of power supply conductors to switch line side terminals.
 - 2. Motor leads to the starter load side terminals.
 - 3. Control conductors to holding coil terminals.
- C. Enclosures: All combination motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.

2.3 MANUAL MOTOR STARTERS:

- A. General: Manual motor starters shall consist of an integral starter and overload protection in a common enclosure, surface-mounted. Size and number of poles shall be as shown and required by equipment served. Furnish pilot light as indicated.

- B. Manual Motor Starter: Manual motor starter with overload protection, one horsepower maximum, 115 or 230 volts; Square D Class 2510 FG-1-(1) Pole, FG-2-(2) Pole; Square D Class 2510 FG-1P-(1) Pole with pilot light, and FG-2P-(2) Pole with pilot light.
- C. Enclosures: All manual motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.
- D. Switch: For self-protected motors where a single pole toggle motor control switch is allowed, the switch shall be as specified for toggle switches in Section 26 27 26, "Wiring Devices".

PART 3 EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS:

- A. General: Install motor starters where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function. Major equipment motor starters located in mechanical rooms that are a part of the main building service shall be located so as to be accessible "within arm's reach" without resort to a ladder.
- B. Overloads: Provide solid state adjustable overload relays in each motor starter. Ratings shall be set based on actual motor nameplate full load amps.
- C. Coordination: Motor starters shall be provided to properly coordinate with motors as furnished by Divisions 23 and 25. Motor starter controls shall be provided to properly coordinate with controls specified in Divisions 23.
- D. Supports: Provide all individual and combination motor starters with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Starters shall not be supported by conduit alone. Where motor starters are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas. All motor starters shall be installed plumb and aligned in the plane of the wall in/on which they are installed.

3.2 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions.
- B. Select and install heater elements in motor starters to match installed motor characteristics.
- C. Mount with operating handle at 5'-6" above finished floor. Align the tops of all grouped starters. Install plumb and aligned in the plane of the wall in which they are installed.
- D. Provide supports of galvanized angle or other suitable material where mounting motor starters on wall or other rigid surface is impractical. Do not support starters from conduit alone. Locate motor starters that are mounted on equipment served so that the starter will not inhibit the removal of any service panel or interfere with required access.
- E. Mount in accessible location to allow sufficient room for maintenance on itself and adjacent items.

F. Securely mount all starters indicated.

3.3 TESTING

- A. Pre-energization Check: Check motor starters for continuity of circuits, short circuits, presents of foreign material, and remedy prior to energizing.
- B. Post Hookup Test: Subsequent to wire and cable hook-ups, energize motor starter and demonstrate satisfactory functioning.
- C. Motor-starter Coordination Documentation: Provide motor-starter coordination documents including, but not limited to, the following information in the operation and maintenance manuals.
 - 1. Motor size in horsepower.
 - 2. Motor full load amps.
 - 3. Motor efficiency.
 - 4. Motor service factor.
 - 5. Size and manufacturer's catalog number of starter and thermal overloads.
- D. Motor Rotation: Verify that motor rotation is correct as connected. Where rotation must be changed, reconnect phase conductors to motor leads at motor junction box.

3.4 IDENTIFICATION

- A. Refer to Section 26 05 53, "Identification for Electrical Systems", for painting and nameplate requirements for all motor starters.
- B. Every starter shall have an internal wiring diagram on the inside of the starter cover and shall be labeled inside the cover to indicate the type and ampacity of thermal overloads installed.

END OF SECTION 261839

SECTION 262200 – LOW VOLTAGE TRANSFORMERS

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. Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
- 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

- 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
- 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Schneider Electric
 2. General Electric Company
- B. Electric Source Limitations: Obtain each transformer type from single source.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.

C. Enclosure: Ventilated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound utilizing a vacuum pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: NSF/ANSI 61 gray.
2. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.
3. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
4. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
5. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
6. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
7. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - a. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - b. Include special terminal for grounding the shield.
8. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
9. Fungus Proofing: Permanent fungicidal treatment for coil and core.
10. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
 - a. 9 kVA and Less: 45 dBA.
 - b. 30 to 50 kVA: 50 dBA.
 - c. 51 to 150 kVA: 55 dBA.
 - d. 151 to 300 kVA: 55 dBA.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
 - 2. Ratio tests at the rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at the rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 - 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to requirements of Division 03 and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 – PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Electronic-grade panelboards.

1.3 RELATED DOCUMENTS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in operation and maintenance manuals. In addition to items specified in "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Two spares for each type of panelboard cabinet lock.
 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service Owner's written permission.
 - 3. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

- 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. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

2. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
1. Panelboards rated 400a and above shall be distribution panelboards as herein specified.
 2. Provide circuit breakers that will selectively coordinate to meet or exceed the available fault current based on the coordination study. Include documentation in the submittal based on manufacturer's selective coordination publication.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
 2. The panelboards shall have door-in door construction.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 2. Square D; a brand of Schneider Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- 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. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 2. Square D, a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and $I^2 t$ response.
 - e. Provide electronic breakers for 60a and above.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

- j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- k. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
- l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

2.6 PANELBOARD SUPPRESSORS

- 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. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 2. Square D; a brand of Schneider Electric.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 EXECUTION

3.2 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

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.
- B. Receptacles shall be hospital grade.

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Isolated-ground receptacles.
 - 4. Tamper-resistant receptacles.
 - 5. Weather-resistant receptacles.
 - 6. Snap switches and wall-box dimmers.
 - 7. Solid-state fan speed controls.
 - 8. Wall-switch and exterior occupancy sensors.
 - 9. Communications outlets.
 - 10. Pendant cord-connector devices.
 - 11. Cord and plug sets.
 - 12. Floor service outlets, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.9 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Pass & Seymour; 5381 (single), 5352 (duplex).
- B. Convenience Receptacles with USB Chargers, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration, UL 498, and FS W-C-596.
 - a. Cooper; TR8355 (duplex)
 - b. Hubbell; USB8300C5W (duplex).
 - c. Pass & Seymour; TR8300HUSBW (duplex).
- C. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell; CR 5253IG.
 - b. Pass & Seymour; IG6300.
 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from

mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.

2.5 TWIST-LOCKING AND OTHER RECEPTACLES

A. Refer to drawings

1. Basis of Design is indicated on drawings. Subject to compliance with requirements, provide that product or an equal by one of the following:
 - a. Cooper
 - b. Hubbell
 - c. Pass & Seymour

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20.

B. Switches, 120/277 V, 20 A:

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. Single Pole:

- 1) Cooper; AH1221.
- 2) Hubbell; HBL1221.
- 3) Pass & Seymour; CSB20AC1.

b. Two Pole:

- 1) Cooper; AH1222.
- 2) Hubbell; HBL1222.
- 3) Pass & Seymour; CSB20AC2.

C. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

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

2. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; 1995.
- b. Hubbell; HBL1557.
- c. Pass & Seymour; 1251.

D. Emergency Power Off

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Pilla Electrical WPSMOCLM Emergency Power Off.

- b. Approved equivalent.

2.9 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider ; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather resistant, die-cast aluminum with lockable cover. Wet location listed while in use.

2.11 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.12 FINISHES

- A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. TVSS Devices: Blue.
 4. Isolated-Ground Receptacles: Orange.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up and on horizontally mounted receptacles to the right.
2. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262800 – COMMISSIONING

PART 1 GENERAL

1.1 SCOPE

A. This section includes commissioning forms for construction verification and functional performance testing.

B. Commissioning Forms

1. CV-26 05 19 Low-Voltage Electrical Power Conductors and Cables
2. CV-26 05 26 Grounding and Bonding for Electrical Systems
3. CV-26 05 33 Raceways and Boxes for Electrical Systems
4. CV-26 05 36 Cable Trays for Electrical Systems
5. CV-26 05 43 Underground Ducts and Raceways for Electrical Systems
6. CV-26 09 19 Enclosed Contactors
7. CV-26 22 00 Low-Voltage Transformers
8. CV-26 24 16 Panelboards
9. CV-26 27 13 Electricity Metering
10. CV-26 27 28 Disconnect Switches
11. CV-26 28 16 Enclosed Switches and Circuit Breakers
12. CV-26 29 00 Magnetic Motor Starters
13. CV-26 29 00 Manual Motor Starters
14. CV-26 36 00 Transfer Switches
15. CV-26 43 13 Surge Protective Devices for Low-Voltage Electrical Power Circuits
16. CV-26 51 13 Interior Lighting Fixtures, Lamps and Ballasts
17. FPT-26 09 23 Network Lighting Control

C. RELATED WORK

1. Section 01 – Commissioning Process

D. REFERENCE

1. Applicable provisions of Division 1 shall govern work under this section.

E. SUBMITTALS

1. Reference the General Conditions of the Contract for submittal requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 COMMISSIONING FORMS

- A. Commissioning forms are to be filled in as work progresses by the individuals responsible for installation and shall be completed for each installation phase.
- B. Provide a description of the work completed since the last entry, the percentage of the total work completed for the system for that area and the step of installation or finalization.
- C. Circle Yes or No for each commissioning form item. If the information requested for an item does not apply to the given stage of installation for the system, list it as "N/A". Explain all discrepancies, negative responses or N/A responses in the negative responses section.
- D. Once the work is 100% complete and the responses to each item are complete and resolved for a given commissioning forms group, mark as complete, initial and date in the spaces provided.
- E. Provide copies of the commissioning forms to the commissioning agent 2 days prior to construction progress meetings.

END OF SECTION 262800

SECTION 262813 – FUSES

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes 250 and 600 volt fuses.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Electrical Commissioning Process

1.3 SUBMITTALS

- A. Provide device dimensions, nameplate nomenclature, and electrical ratings.
- B. Submit manufacturer's product data sheets with installation instructions.

1.4 REGULATORY REQUIREMENTS

- A. Listed by Underwriter's Laboratories, Inc., and suitable for specific application.

1.5 EXTRA MATERIALS

- A. Provide three (3) spares of each size and type fuse.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fuses 600 Amperes and Less: Dual element, time delay, 250 volt, UL Class RK 5, J Interrupting Rating: 200,000 rms amperes.
- B. Fuses 601 Amperes and Larger: Low Peak, time delay, 600 volt, UL Class L. Interrupting Rating: 200,000 rms amperes.
- C. Fuses 30 Amperes and less: Time-Delay, 600 volt, UL Class CC. Interrupting rating: 200,000 rms amperes.
- D. Provide storage enclosure for spare fuses. Enclosure shall be a hinged-cover junction box, minimum size of 12" x 12" x 6" D. Enclosure shall be labeled as "Spare Fuses". Install enclosure in main electrical room.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Fuses shall not be installed until equipment is ready to be energized.

END OF SECTION 262813

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
- B. Shop Drawings: For enclosed switches. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10 > percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 2. Altitude: Not exceeding 6600 feet (2010 m).

1.9 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 NONFUSIBLE SWITCHES

- A. Manufacturers
 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 2. Siemens Energy & Automation, Inc.

- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Accessory Control Power Voltage: Integrally mounted, self-powered; 24-V ac

2.2 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following
 - 1. ABB, formerly General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 2. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I²t response.
 - 5. Provide electronic breakers for 60a and above.

- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- H. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
 - 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 10. Accessory Control Power Voltage: Integrally mounted, self-powered; 24-V ac.

2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1
 - 2. Outdoor Locations: NEMA 250, Type 3R
 - 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTIONS

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports: Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816

SECTION 262913 – ELECTRICITY METERING

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes electronic meters including test switch and instrument transformers as specified herein and shown on the Drawings.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
 - 1. Section 26 05 500 – Basic Materials and Methods
 - 2. Section 26 20 00 – Low Voltage Electrical Transmission

1.3 REFERENCES

- A. ANSI C57.13 - Instrument Transformers

1.4 SUBMITTALS

- A. Provide product data showing model numbers, dimensions, mounting requirements, and parameters measured and displayed.
- B. OPERATION AND MAINTENANCE DATA
 - 1. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 ELECTRONIC METER at NEW PANELBOARDS (Non-Utility Metering)

- A. Electronic meter with 4-line by 20-character backlit digital display (LED or LCD), shall accept input from standard current transformers rated 5 amperes. Meters for systems operating at 480V and below shall measure circuit potential without the use of external potential transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system or a three-phase, three-wire delta system.
- B. Meter accuracy shall meet or exceed ANSI C12.20 and MID accuracy standards.
- C. Meter shall be UL/CUL listed to latest applicable standards for safety.
- D. Meter shall provide non-volatile memory to maintain reading during power outages.
- E. Meter shall provide installation diagnostics on display.
- F. Meter shall store interval data for kWh and kVARh for up to 72 days in first-in first-out format. Interval data not available via BACnet.
- G. Meter shall be optionally available in single-phase, 3-wire configuration.

- H. Meter shall be capable of daisy-chain connection using RS-485 communications of Din-Mon D2 & D5, Class 3200s, 3400s, 5000s, IDR-8s, IDR-16s not to exceed 52 devices. Cabling shall be available through terminal block (3-conductor), 18-22 awg, up to 4,000 cable feet total.
- I. Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:
 - 1. Current: per phase
 - 2. Voltage: phase-to-phase and phase-to-neutral
 - 3. Real Power (kW): three-phase total
 - 4. Reactive Power (kVAR): three-phase total
 - 5. Apparent Power (kVA): three-phase total
 - 6. Power Factor: three-phase
 - 7. Real Energy (kWh): three-phase total
 - 8. Maximum Demand:
 - 9. Real Power (kW): three-phase total
 - 10. Apparent Power (kVA): three-phase total
- J. All meter potential leads and control power leads shall be fuse protected. Provide a fused disconnecting device or circuit breaker with downstream fuses in the main switchboard or panelboard for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.
- K. Meter shall utilize 0-2 volt AC output current sensors to allow paralleling and/or mounting up to 500 feet from the meter. Sensors shall be of split-core configuration to allow installation without disconnecting cabling, etc. Sensors shall be available from 100 amp to 3200 amp. Sensors shall be available in solid-core configuration (100 & 200amp.)
- L. Meter shall be E-Mon D-Mon Class 3200, Advanced kWh/Demand Meters with Communication wiring from the interface gateway to the IT closet.
- M. The contractor shall be responsible for data wiring and jack termination as specified under division 27 and the paragraph below unless specified to be provided by the division 27 contractor.
- N. Building Automation System (BAS) data jacks will be installed according to the campus standard except that a data jack is not needed and a patch cord can be used between the utilizing equipment and the network switch port under the following exceptions:
 - 1. If the utilizing equipment is mounted on or within the vertical sides of the floor or wall rack.
 - 2. If the utilizing equipment is mounted within the same telecommunications room and can be reached with a 40 foot or shorter patch cord that is routed with existing cabling in the racks, trays, J-hooks, etc....and is not stretched tight.
 - a. NOTE: If a patch cord is used in exceptions A or B above, the patch cord must be labeled on each end listing the termination point on the opposite end.
 - b. EXAMPLE:

1) Switch name and port #.....to.....equipment name s-weeks-156-1-
access, port 22.....MS-SECVT0 north wall

3. Provide a Meter Interface Gateway as described in the “Meter Interface Gateway” subsection of this specification.

2.2 METER TEST SWITCH

- A. Provide a 600 volt ten-pole (4 potential and 6 current shorting) test switch with cover, ABB Type FT-1, or approved equal, connected between each meter and the CT and potential leads. The six leads (2 per phase) from the CT's shall be connected to the current shorting terminal positions on the test switch. The four leads ((3) phase and (1) neutral) from the PT's or bus shall be connected to the potential terminal positions. The test switch shall be located on the face of the switchgear adjacent to the meter or behind a panel cover in an easily accessible location.
- B. Meter test switch is required on all meter installations at switchboards and main distribution panels. Meter test switch is not required for sub-meters, or meters installed at branch panels, automatic transfer switches, and other downstream locations.

2.3 SUB-METER(S) FOR EXISTING PANELBOARDS

- A. Electronic meter with digital display shall accept input from standard current transformers rated 5 amperes. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system, a three-phase, three-wire delta system, or a 120/240V single-phase system.
 - 1. Meter specification is based on Electro Industries Shark 100.
 - 2. Provide approved equivalent acceptable to Owner.
- B. Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
- C. Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:
 - 1. Current: per phase
 - 2. Voltage: phase-to-phase and phase-to-neutral
 - 3. Real Power (kW): three-phase total
 - 4. Reactive Power (kVAR): three-phase total
 - 5. Apparent Power (kVA): three-phase total
 - 6. Power Factor: three-phase
 - 7. Real Energy (kWh): three-phase total
 - 8. Maximum Demand:
 - 9. Real Power (kW): three-phase total
 - 10. Apparent Power (kVA): three-phase total
- D. Provide Meter Interface Gateway per the paragraph included in this specification section.

- E. Provide additional fusible disconnect switch(es)/circuit breaker(s) and enclosures per the PROVISIONS FOR SUB-METERS paragraph included in this specification section.

2.4 METER INTERFACE GATEWAY

- A. Provide a meter interface gateway to allow the meter(s) (daisy-chained to a single interface location) to communicate with the BAS system protocol listed below. The interface gateway shall convert the meter data from the meter's native language to the BAS protocol.
- B. If the meters can communicate with the BAS system without the use of an interface gateway, then no gateway is required.
- C. Building Automation System (BAS) communication protocol:
 - 1. BACnet/IP. Meters that have internal BACnet/IP communication interface: The Main Electric Service meter and all Sub-meters shall have a BACnet/IP interface (either on-board or a separate gateway) to the BAS system.
 - 2. Requires E-Mon Energy software for reading: EZ7 RS-232/RS-485 hard-wire connection (standard)
 - 3. Requires third-party EMS/BMS system supplied by others. E-Mon energy software not used: Modbus RTU Communications (Replace EZ7 in model with RTU when ordering).

BACnet MS/TP (Replace EZ7 in model with BAC when ordering).
- D. Manufacturers of gateway devices that can provide a BACnet interface for electrical meters with other native protocols: Industrial Control Communications, Inc. - Millennium Gateway Series, Real Time Automation – 460 Series, Delta Controls DSM-PWR, FieldServer, Tridium, or Johnson Controls. All programming of the gateway device to provide the BACnet objects to the building automation system shall be included.
- E. The interface gateway shall transmit all of the measured values listed under the meter descriptions in this specification section.

2.5 PROVISIONS FOR SUB-METERS

- A. OVERCURRENT PROTECTION FOR POTENTIAL LEADS AND CONTROL POWER LEADS
 - 1. If the sub-meter(s) are located in the main switchboard, provide a fusible disconnect or circuit breaker in the metering section of the switchboard for the protection of the potential transformers or potential leads as required for the sub-meter(s). If the sub-meter(s) are located adjacent to a panelboard, then the contractor must provide a 3-pole 15 amp circuit breaker in that panelboard as required for the potential transformers or potential leads for the sub-meter(s).
 - 2. All meter potential leads and control power leads shall be fuse protected. Provide fuses in the disconnecting device or downstream fuses from the circuit breaker for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.
- B. ENCLOSURE(S)
 - 1. Meter shall be enclosed in an MMU-8 Cabinet, NEMA 4X JIC steel enclosure with padlocking hasp and mounting flanges for indoor/outdoor installation (stand alone) with one 1 1/16" KO on bottom of enclosure. Provide optional heavy duty JIC steel enclosure for indoor installation.

2.6 ACCESSORIES

- A. Provide shorting block(s) for the CT leads.

2.7 CURRENT TRANSFORMERS

- A. Current Transformers: ANSI C57.13; 5 ampere secondary, with primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
- B. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers.
- C. Mount and brace transformers to withstand 100,000 amp short circuit current.

2.8 POTENTIAL TRANSFORMERS

- A. Provide potential transformers (PT's) only if required by the meter manufacturer. Most meters can measure 480V potential and below without the use of external PT's.
- B. Potential Transformers: ANSI C57.13; 120 volt secondary, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
- C. Potential transformers on 480/277 volt systems shall be rated 277 – 120 volts, connected phase-to-neutral, and installed on each phase.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The meters shall be mounted in the locations indicated on the drawings. Mounting height shall be 5'-6" or less from finished floor.

3.2 CONSTRUCTION VERIFICATION

- A. Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

3.3 AGENCY TRAINING

- A. All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION 262913

SECTION 263613 - MANUAL TRANSFER SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low-voltage manual transfer switches.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads

1.3 ABBREVIATIONS AND ACRONYMS

- A. MTS: Manual transfer switch.

1.4 DEFINITIONS

- A. Manual transfer switches may also be identified as MTS.

1.5 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components; 2010, with Editorial Revision (2015).
- D. ISO 9001 - Quality Management Systems — Requirements; 2015.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 99 - Health Care Facilities Code; 2021, with Amendment.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 891 - Switchboards; Current Edition, Including All Revisions.
- K. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.
- L. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.

1.7 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.
- C. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.
- D. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
- E. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections.
 - 1. Include sequence of operations.
- F. Seismic Qualification Certification: (NOT APPLICABLE FOR THIS PROJECT)
 - 1. Certificate of compliance.
 - 2. Dimensioned equipment outline drawings identifying center of gravity and mounting/anchoring provisions.
 - 3. Details and installation requirements of equipment anchorage devices on which certification is based. Consider if operational readiness testing is specified in Part 3.
- G. Operational Readiness Report:
 - 1. Document test results, including assumptions, conditions, allowances, and corrections made.
 - 2. Provide listing of field modifications and adjustments made including settings/parameters not identified as factory defaults within equipment's operations and maintenance manual documentation.
 - 3. Include certification, signed by Contractor and manufacturer's representative, that equipment and associated system have been installed, configured, and tested in accordance with manufacturer's recommendations, conforms to requirements of Contract Documents, and is ready for operation.
- H. Manufacturer's qualification statement.
- I. Installer's qualification statement.
- J. Operation and Maintenance Data:

1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- K. Specimen warranty.
- L. Executed warranty.
- M. Project Record Documents:
1. Construction, installation, schematic, and wiring diagrams updated to as-installed and commissioned state.
 2. Configured settings/parameters for adjustable components updated to as-installed and commissioned state, noted if different from factory default.
- N. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
1. See Section 016000 - Product Requirements for additional provisions.
 2. Spare Parts: For each type and size of unit installed.
 - a. Provide minimum spare parts recommended by manufacturer.
 - b. Identify the following:
 - i) Contact information for closest parts stocking location to the Owner.
 - ii) Critical spare parts associated with long lead times and/or critical to unit's operation.
 - iii) Maintenance spares required to regularly perform scheduled maintenance, including but not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
 - c. Fuses: One set of each type of power and control fuse installed within equipment.
 - d. Package and mark spare parts for long-term storage. Provide separate anti-static containers for printed circuit boards.
 3. Tools: Manufacturer-specific special tools required to install, remove, test, and maintain transfer switch components.

1.8 QUALITY ASSURANCE

- A. Comply with the following:
1. NFPA 70.
 2. NFPA 99 includes requirements for health care facilities.
 3. Requirements of authorities having jurisdiction.
 4. Applicable local codes.
- B. Manufacturer Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
 2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
 3. Service, repair, and technical support services available 24 hours per day, 7 days per week, 365 days per year from manufacturer or their representative.
 4. Maintain records of each switch, by serial number, for minimum of 20 years.
- C. Installer Qualifications: Firm with minimum 10 years experience with transfer switches of similar type and scope; approved by manufacturer's representative.
- D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.
- C. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.
- D. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.
- E. Inspect products and report damage or violation of delivery, storage, and handling requirements to Engineer.

1.10 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 24 months from date of shipment. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

MANUAL TRANSFER SWITCHES

Schneider Electric; ASCO 300 Series; www.ascopower.com/#sle.

- B. PowerTemp.
- C. Trystar.
- D. Substitutions:
- E. Source Limitations: Provide manual transfer switches and accessories obtained from single supplier.

2.2 LOW-VOLTAGE MANUAL TRANSFER SWITCHES

- A. Basis of Design: Schneider Electric; ASCO 300 Series; www.ascopower.com/#sle.
- B. Description: Transfer switches consisting of three-position, center-off mechanically held power transfer switch unit for manual operation.
- C. Do not use double-throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.
- D. List and label as complying with UL 1008 and, for systems with integrated circuit breakers, UL 891.
- E. Transfer Switch Ratings/Configurations: As indicated on drawings.
- F. Manual Transfer Switch Number:
 - 1. Frame: 150 A to 600 A.
 - 2. Configuration: Manual transfer switch with quick connects (available up to 1,200 A, Type 3RX only).
 - 3. Neutral Configuration: Solid neutral.
 - 4. Phase Poles: As indicated on drawings.
 - 5. Ampere Rating: As indicated on drawings.
 - 6. Voltage: As indicated on drawings.
 - 7. Enclosure: Type 3RX secure, 316 stainless steel.
 - 8. Provide the following accessories:
 - a. Strip heater with thermostat.
 - b. Surge protective device.
 - c. User interface/annunciation bundle.
- G. Service Entrance Rated Transfer Switches:

1. Grounding/Bonding Provisions:
 - a. Provide ground bus for connection of grounding conductor to grounding electrode.
 - b. Provide disconnect link for neutral-to-ground bonding jumper to connect normal neutral connection to ground bus.

- H. Transfer Switch Construction:
 1. Manually operated, mechanically held.
 2. Positively locked, unaffected by momentary outages, such that contact pressure is maintained at constant value and contact temperature rise is minimized for maximum reliability and operating life.
 3. Mechanically interlocked to allow only one of three possible positions:
 - a. Connected to SOURCE 1 (preferred).
 - b. Connected to SOURCE 2 (alternate).
 - c. CENTER OFF (disconnected position).
 4. Provide capability to pad-lock switch when connected to SOURCE 1 or SOURCE 2.
 5. Main Contacts: Silver composition.
 6. Switches Rated 600 A and Greater: Provide segmented, blow-on construction for high withstand and close-on capability, protected by separate arcing contacts.
 7. Designed to allow inspection of contacts from front without disassembly of operating linkages and disconnection of power conductors.
 8. Devices utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
 9. Manual Operating Handle: Capable of external operation without opening enclosure door.
 10. Provide same contact-to-contact speed as automatic operation.
 11. Provide (2) 100% rated electronic type LSIA breakers with meters.

- I. Withstand and Closing Ratings: Rate to close on and withstand available RMS symmetrical short circuit current at terminals with overcurrent protection indicated.

- J. Quick Connects:
 1. Provide 16 Series camlock single-pole connectors.
 2. Color Code:
 - a. Phases, 240 V and Below: Black, red, and blue.
 - b. Phases, 480 V: Brown, orange, and yellow.
 - c. Neutral: White.

d. Ground: Green.

K. Neutral Configurations:

1. Solid Neutral: Provide neutral conductor plate with fully rated AL-CU pressure connectors.
2. Switched Neutral: Provide fully-rated switched (break-before-make) neutral transfer contacts.

L. Endurance Ratings:

1. Switches Rated 260 A and Less: 6,000 cycles.
2. Switches Rated 400 A: 4,000 cycles.
3. Switches Rated 600 A to 3,000 A: 3,000 cycles.

M. Enclosures:

1. Construction: Steel.
2. Mounting: Free-standing, floor-mounted.
3. Comply with UL 50.
4. Finish: ANSI 61 grey powder coat.
5. UL 50E Rating, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3RX,SS.
6. Provide nameplate with drawing numbers and serviceable part numbers to facilitate maintenance.

N. Status Indication: Provide yellow mechanical position indicators visible to operator for SOURCE 1 (preferred), SOURCE 2 (alternate), and CENTER OFF.

O. Seismic Qualification: (NOT APPLICABLE FOR THIS PROJECT)

1. Provide independent third-party testing for compliance with ICC (IBC)/ASCE 7, certifying that equipment will remain operable following design level earthquake.
2. Perform shake table testing in accordance with ICC-ES AC156, using importance factor (Ip) of 1.5.

P. Enclosure Heater:

1. Provide for transfer switches installed outdoors.
2. Provide thermostat and terminal block.
3. Capable of being added to existing switches.

4. Provide connection to load terminals.

Q. Surge Protective Device:

1. Listed as complying with UL 1449.
2. Surge Current Rating: 100 kA per mode, 200 kA per phase.
3. Provide individually matched fused metal oxide varistors (MOVs).
4. Provide LED status indication of normal operation, undervoltage, power loss, phase loss, and component failure.
5. Provide Form C dry contacts for external alarm/monitoring.

R. User Interface/Annunciation Bundle:

1. Provide LED indicators for SOURCE 1 (preferred) and SOURCE 2 (alternate).
2. Provide auxiliary position indicating contacts, rated 10 A, 250 VAC - one closed when connected to SOURCE 1 and one closed when connected to SOURCE 2.
3. Provide Form A contact to indicate switch in CENTER OFF position.
4. Provide keyed maintained engine start switch/output with common alarm input/LED/contact.
5. Provide phase rotation monitor.
6. Provide I/O module.

2.3 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Factory test for proper operation of individual components and compliance with sequence of operation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.
- B. Examine for conditions detrimental to completion of work.
- C. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.
- B. Install transfer switches in accordance with NECA 1.

- C. Unless otherwise indicated, install and anchor floor-mounted transfer switches on raised concrete pad high; see Section 033000.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
 - 1. Include necessary material, equipment, labor, and technical supervision.
 - 2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
 - 3. Identify transfer switches with label indicating inspection/testing agency and date of service.
- C. Operational Readiness Testing:
 - 1. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer's recommendations, and readiness for operation.
 - a. Visually inspect for physical damage and proper installation.
 - b. Perform tests in accordance with manufacturer's instructions.
 - c. Perform tests to verify compliance with Contract Documents.
 - d. Perform tests to verify equipment is ready for operation.
 - e. Touch-up paint chips and scratches with manufacturer-supplied paint.
- D. Correct deficiencies and replace damaged or defective transfer switches or associated components.

3.4 PROTECTION

- A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION

SECTION 264113 - LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes all labor, material, equipment and related services necessary to install a new building lightning protection system. Submit a written report and document certification that the system is up to current standards after installation. System grounding shall be verified and identified as internal grounding or external driven ground rods, and tested to verify that all grounding is functional.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
 - 1. Section 07 63 00 – Sheet Metal Roofing Specialties
 - 2. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
 - 3. Section 26 05 26 – Grounding and Bonding for Electrical Systems
 - 4. Section 26 05 33 – Raceways and Boxes for Electrical Systems

1.3 REFERENCE STANDARDS

- A. LPI- Lightning Protection Institute
- B. NFPA - 780 "Lightning Protection Code"
- C. UL-96A "Installation Requirements for Lightning Protection Systems"

1.4 DESIGN CRITERIA

- A. Lightning protection system shall be furnished and installed in compliance with provisions of the latest edition of Applicable codes and standards to obtain a UL Inc. "Master Label". The "Master Label" certification process is required for this project.
- B. If any departures from the contract documents are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted as soon as practicable to the Architect/Engineer for approval. No such departures shall be made without the prior written approval of the contracting officer and the Owner's Representative.

1.5 QUALIFICATIONS OF MANUFACTURING AND INSTALLING FIRMS

- A. The system to be furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design.
- B. Equipment manufacturer shall be a UL listed and approved manufacturer and a fully certified manufacturer member in good standing of the Lightning Protection Institute (LPI).

- C. Installation of equipment shall be done under the direct on-site supervision of an LPI manufacturer as listed above; or their authorized LPI Certified Master Installer representative; or an experienced installer who is a Certified Master Installer of the LPI.

1.6 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be submitted for all materials provided under this Section.
2. Submit installation drawings showing the type, size and location of all equipment, ground connections and cable routings, etc.

- B. Samples shall be submitted to Architect/Engineer for approval upon request.

1.7 GUARANTEE

- A. Guarantee for one year after acceptance by the Owner's Representative all equipment, materials and workmanship to be free from defect.
- B. Provide replacement parts for components found defective at no extra cost to the Owner.

PART 2 PRODUCTS

2.1 FABRICATION AND MATERIALS

A. Air Terminals:

1. Air terminals shall be 1/2" x 18" solid copper and shall project at least 10" above the object to be protected. All air terminal bases shall be cast copper/bronze with stainless steel bolt-pressure cable connectors.

B. Main Conductors:

1. Main conductors shall consist of U.L. listed; Class 11, 115,000 CM, minimum 16 AWG strands, copper wire installed in accordance with the U.L. Code.

C. Concealed Conductors:

1. All concealed conductors shall be installed in Schedule 40 1" PVC conduit. Conduit to be furnished and installed by the Electrical Contractor.

D. Down Conductors:

1. Each main conductor shall be connected to at least 2 down conductors. The average distance between down conductors shall not exceed 100 feet.

E. Fasteners:

1. Conductor fasteners shall be an approved type of non-corrosive metal, have ample strength to support conductors and shall be spaced not to exceed 3'-0" centers. Masonry type cable fasteners spaced every 3'-0" on masonry. Adhesive type cable fasteners spaced every 3'-0" on flat surfaces.

F. Cable Connectors:

1. All cable connectors shall be cast copper/bronze with bolt-pressure type stainless steel bolts and nuts. Cast or stamped crimp fittings are not acceptable.

G. Ground Terminals:

1. Ground rods shall be 3/4" in diameter and 10'-0" long and shall be driven to minimum depth of 10' or more if necessary to reach permanent moisture.
2. Locate ground rods at the perimeter of the structure, at intervals not exceeding 100'-0".
3. If rock or other conditions make it impossible to comply with the above, provide a copper plate, providing it will meet the Underwriters Laboratories, Inc. requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install system in accord with UL and NFPA requirements.

B. Interconnection of Metals:

1. Bond all metal bodies within 6' of the conductors to the system with approved fittings and conductor. Connections between dissimilar metals shall be made with approved bimetallic connections.
2. Bond all metallic objects and systems at roof levels and elsewhere on the structure. Primary bonds for metal bodies of conductance shall be bonded with appropriate fittings and full-size secondary conductor; and shall consist of but not be limited to the following: exhaust fans, ductwork, exhaust vents and any other piping systems, handrails and/or screens, ladders, metal plumbing stacks, etc. Exterior architectural metal fascia and/or curtain walls or mullions, which extend the full height of the structure, shall also be bonded, if not inherently bonded thru the building frame.
3. Secondary conductors must pass continuously horizontally or down from point of bond to point of connection to main conductor.

3.2 SYSTEM TEST

A. Provide a Ground Loop Conductor (GLC) continuity test, wire to wire to test resistance. Submit written results of the test. Statement shall be provided on Installer's letterhead paper.

B. Perform an Ohm test at each down conductor. Submit written results of the test. Statement shall be provided on Installer's letterhead paper.

END OF SECTION 264113

SECTION 264313 – SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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. Type 1 surge protective devices.
 - 2. Enclosures.
 - 3. Conductors and cables.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. NRTL: Nationally recognized testing laboratory.
- F. OCPD: Overcurrent protective device.
- G. SCCR: Short-circuit current rating.
- H. SPD: Surge protective device.
- I. Thermally Protected MOV: An electronic component with a significant non-ohmic current-voltage characteristic.
- J. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device. Type 1 SPDs can be used anywhere in the facility and do not require external over-current protection devices
- K. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.
- L. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include electrical characteristics, specialties, and accessories for SPDs.
2. Include Shop Drawings complete with all technical information, unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.
3. Copies of manufacturer's catalog data, technical information and specifications on equipment proposed for use.
4. Copies of documentation stating that the SPD is listed by UL to UL 1449 4th Edition, category code VZCA.
5. Copies of actual let-through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
6. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50kHz and 100MHz verifying the device's noise attenuation. Must show multiple attenuation levels over a range of frequencies. Test criteria must be based on 6 ft (1.8 m) of lead length.
7. NRTL certification of listing to UL 1449.
 - a. Tested values for VPRs.
 - b. Inominal ratings.
 - c. MCOV, type designations.
 - d. OCPD requirements.
 - e. Manufacturer's model number.
 - f. System voltage.
 - g. Modes of protection.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Copies of test reports from a third party, recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per-mode basis using the 8 x 20 microsecond wave shape. Test data on an individual module are not acceptable.
- C. Copies of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.
- D. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions within 20 years from date of Substantial Completion.

1. Warranty includes damage caused by lightning strikes or transient utility faults.

PART 2 PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide ABB Electrification Products Industrial Solutions; Current Technology – SL3 Series, Selenium and Thermally protected metal-oxide varistor hybrid SPD or comparable product by one of the following:

1. ASCO; 560 Series.
2. Joslyn

- B. Source Limitations: Obtain devices from single source from single manufacturer.

- C. Standards:

1. Listed to UL 1449, 4th Edition as a Type 1 SPD and UL 1283.
2. Comply with NFPA 70.

- D. Product Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status. Indicator light shall change color to indicate percentage of protection remaining: Green 100-70 percent, Orange 70-40 percent, and Red <40 percent.
4. Include audible alarm, with an alarm disable button.
5. Include two sets of NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V ac for remote monitoring of protection status.
6. Include surge counter.

- E. Performance Criteria:

1. Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL 1449, section 37.7.3. MCOV values based on the component's value or on the 30-minute 115 percent operational voltage test, section 38 in UL 1449, will not be accepted.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA for service entrance locations and not less than 200 kA for Panelboard locations.
3. Unit shall have no more than 10 percent deterioration or degradation of the UL 1449 4th Edition Voltage Protection Rating (VPR) when exposed to a minimum of 15,000 repeated category C3 (20kV/10kA) surges. SPD manufacturer must provide a test report validating the repetitive surge test was performed.
4. Protection Modes UL 1449 4th Edition VPR (6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347). Three-phase, four-wire circuits, (120/240) split-phase shall be as follows and comply with test procedures outlined in UL 1449, section 37.6.
 - a. System Voltage: 240/120, 208/120.
 - 1) Mode: L-N:
 - a) MCOV: 150.
 - b) B3 Ringwave 6kV, 500A: 490.
 - c) C3 Combined Wave, 20kV, 10kA: 980.
 - d) UL 1449 Fourth Edition VPR Rating: 700.
 - 2) Mode: L-G:
 - a) MCOV: 150.
 - b) B3 Ringwave 6kV, 500A: 570.
 - c) C3 Combined Wave, 20kV, 10kA: 980.
 - d) UL 1449 Fourth Edition VPR Rating: 700.
 - 3) Mode: N-G:
 - a) MCOV: 150.
 - b) B3 Ringwave 6kV, 500A: 640.
 - c) C3 Combined Wave, 20kV, 10kA: 1170.
 - d) UL 1449 Fourth Edition VPR Rating: 700.
 - 4) Mode: L-L:

- a) MCOV: 300.
 - b) B3 Ringwave 6kV, 500A: 500.
 - c) C3 Combined Wave, 20kV, 10kA: 1600.
 - d) UL 1449 Fourth Edition VPR Rating: 1200.
5. SCCR: The rating of the SPD shall be 200kAIC without the need for upstream over current protection.
 6. Inominal Rating: 20 kA.
 7. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter with a maximum attenuation of 54dB per MIL-STD-220B. These test criteria must be based on 6-inch (13-mm) lead length.
 8. SPD shall include an EMI/RFI noise rejection filter for all L-N modes as well as a removable filter in the N-G mode.
 9. SPD unit shall be able to prevent common temporary overvoltage's and high-impedance faults from damaging the MOVs, increasing their longevity and ability to protect the critical load. Limited and intermediate current TOVs (as specified in UL 1449 article 39.3 and 39.4) can be caused by a loss of the neutral conductor in a split-phase or three-phase power system. The available fault current will be determined by the impedance of the loads connected to the phases opposite the SPD and are typically in the range of 30A to 1000A. The Selenium elements must limit voltage to the MOV as a percent of nominal as outlined below:
 - a. 1 cycle: 120 percent at 30A, 130 percent at 100A, 150 percent at 500A, 160 percent at 1000A.
 - b. 10 cycles 130 percent at 30A, 150 percent at 100A, 160 percent at 500A, 160 percent at 1000A.
 - c. 30 cycles 140 percent at 30A, 150 percent at 100A, 160 percent at 500A, 160 percent at 1000A.
 10. Unit shall be able to withstand multiple TOVs without damage to the MOVs by shunting current away from the MOVs during the overvoltage. SPD must have the ability to withstand >100 TOVs with a source current of 30A, duration of 30 cycles, with 10s between TOV events.
 11. The service entrance protector shall incorporate a combination of Thermally Protected MOV and Selenium technology allowing for transient surge, temporary and sustained over voltage protection.
 12. SPD shall be externally mounted to the switchgear and/or panelboard. Internally mounted SPDs will not be accepted.

2.2 TYPE 4 SURGE PROTECTIVE DEVICES (SPDs)

- A. Type 4 SPDs are not approved for field installation.

2.3 SERVICE ENTRANCE.

A. Basis-of-Design Product: Current Technology - Select3 or SL3 Series 200kA per mode surge rating.

1. SPD's shall have the following features:

- a. Integral Disconnect Switch: Device shall have an optional NEMA-compliant safety interlocked integral disconnect switch with an externally mounted metal manual operator.
 - 1) Switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility's distribution system.
 - 2) Switch shall be rated for 600 V ac and fully surge rated.
 - 3) SPD device shall be tested to UL 1449 4th Edition listed with the integral disconnect switch and the UL 1449 VPR ratings shall be provided.
 - 4) Integral disconnect switch shall be capable of withstanding the published maximum surge current magnitude without failure or damage to the switch.
 - 5) Line side of the integral disconnect shall be blocked off so that when the SPD is opened there is no direct access to the voltage present on the line side of the disconnect.
- b. UL 1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.
- c. UL 1449 Nominal Discharge Surge Current Rating: 20kA.
- d. SCCR Rating of the SPD: 200kAIC without the need for upstream over-current protection
- e. SPD shall be listed as Type 1 SPD, suitable for use in Type 1 or Type 2 applications.
- f. SPD shall have monitoring options to include time/date stamp, duration and magnitude for the following power quality events, sags, swells, surges, dropouts, outages, THD, frequency, Volts RMS per phase. SPD monitoring shall track surge protection and display it as a percentage of remaining protection. SPD shall provide a surge counter with three categories to be defined as Low Level surge (100A-500A) Medium Level surge (500A-3,000A), and High Level surge (>3,000A). The SPD shall have remote communications via ModBus or Ethernet. The unit shall have tri-color LED indicators for instant verification of power and protection status of each phase. The SPD shall have Form-C contacts rated at 5 A and 250 V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of the unit or loss of AC power.

2.4 PANEL SUPPRESSORS

A. Basis-of-Design Product: Transguard3 or TG3 Series 200kA per mode surge rating or approved equivalent.

B. SPDs: Comply with UL 1449, Type 1.

1. SPDs with the following features and accessories:
 - a. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise-rejection filter with a maximum attenuation of 54dB per MIL-STD-220B.
 - b. SPD shall include an EMI/RFI noise-rejection filter for all L-N modes as well as a removable filter in the N-G mode.
 - c. Integral Disconnect Switch: Device shall have an optional NEMA-compliant safety interlocked integral disconnect switch with an externally mounted metal manual operator.
 - 1) Switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility's distribution system.
 - 2) The switch shall be rated for 600 V ac.
 - 3) SPD device shall be tested to UL 1449 4th Edition listed with the integral disconnect switch and the UL 1449 VPR ratings shall be provided.
 - 4) Integral disconnect switch shall be capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.
 - 5) Line side of the integral disconnect shall be blocked off so that when the SPD is opened there is no direct access to the voltage present on the line side of the disconnect.
2. The UL 1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.
3. UL 1449 Nominal Discharge Surge Current Rating shall be 20kA.
4. SCCR rating of the SPD shall be 200kAIC without the need for upstream over current protection.
5. SPD shall be listed as Type1 SPD, suitable for use in Type 1 or Type 2 applications.
6. SPD shall have monitoring options to include time date stamp, duration and magnitude for the following power quality events (sags, swells, surges, dropouts, outages, THD, frequency, Volts RMS per phase). SPD monitoring shall track surge protection and display it as a percentage. SPD shall provide a surge counter with three categories to be defined as Low Level surge (100A-500A), Medium Level surge (500A-3,000A), and High Level surge (>3,000A). SPD's remote communications via ModBus or Ethernet. The unit shall have tri-color LED indicators for instant verification of power and protection status of each phase. The SPD shall have Form-C contacts rated at 5 A and 250 V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of the unit or loss of AC power.

2.5 ENCLOSURES

- A. Indoor Enclosures: NEMA 4/12.
- B. Outdoor Enclosures: Type 3R.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Termination leads from the SPD to the intended protected load shall be kept as short and straight as possible, avoiding 90 degree bends in the wire. If the installation lead length must exceed 5 feet (1.5 m), then the SPD manufacturer shall provide a low-impedance cable system to minimize the additional lead lengths impact to the installed performance of the SPD.
 - 1. Basis of Design Product: Current Technology model HPI, a high-performance, low-impedance cable.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions, applicable NEC codes, local codes, and the requirements of the authority having jurisdiction.
- B. If an OCPD or disconnect is desired for installation of SPD, it must be in accordance with UL 1449 and manufacturer's written instructions.
- C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's written instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 - 2. Do not exceed manufacturer's recommended lead length.
 - 3. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. SPDs that do not pass tests and inspections will be considered defective.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. SPD manufacturer's technician shall perform a system checkout and start-up in the field to ensure proper installation, operation, and to initiate the warranty of the system. Technician will be required to do the following:
 - 1. Verify voltage clamping levels utilizing a diagnostic test kit, comparing factory benchmark readings to installed readings.
 - 2. Verify N-G connection.
 - 3. Record information to a product signature card for each product installed.
- B. Unit may be installed on either the line or load side of the main service disconnect.
 - 1. If installed on the line side, unit shall be installed with an integral disconnect.
 - 2. If installed on the load side, unit shall be installed on the largest breaker size available.
 - 3. If installed lead length exceeds 5 ft (1.5 m), Installer shall use a low-impedance (HPI) cable to reduce the lead length's effect on the installed performance of the SPD
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

SECTION 265119 – LED INTERIOR LIGHTING

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. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

- A. Retain terms that remain after this Section has been edited for a project.
- B. CCT: Correlated color temperature.
- C. CRI: Color Rendering Index.
- D. Fixture: See "Luminaire."
- E. IP: International Protection or Ingress Protection Rating.
- F. LED: Light-emitting diode.
- G. Lumen: Measured output of lamp and luminaire, or both.
- H. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Arrange in order of luminaire designation.
 2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.
 4. Include emergency lighting units, including batteries and chargers.
 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 6. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For testing laboratory providing photometric data for luminaires
 - B. Product Certificates: For each type of luminaire.
 - C. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
 - D. Sample warranty.
- 1.6 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
- 1.7 QUALITY ASSURANCE
- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 - B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
 - C. Provide luminaires from a single manufacturer for each luminaire type.
 - D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- 1.8 DELIVERY, STORAGE AND HANDLING
- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. CRI of minimum 80 . CCT of 4100 K.
- F. Rated lamp life of 50,000 hours.
- G. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- H. Internal driver.
- I. Nominal Operating Voltage: 120 V ac and 277 V ac. See Schedule on Drawings,
- J. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- K. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Clear silver anodized powder-coat painted finish.

2.2 STRIP LIGHT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: See Drawings.

2.3 SURFACE MOUNT, LINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: See Drawings.

2.4 SURFACE MOUNT, NONLINEAR

- 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: See Drawings.

2.5 SUSPENDED, LINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: See Drawings.

2.6 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.7 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Prismatic glass prismatic acrylic and clear, UV-stabilized acrylic
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Glass: Annealed crystal glass unless otherwise indicated.
 - 4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated
- D. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Clear anodized finish.
- E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires

2.8 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.9 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage .
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug..

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
2. Ceiling mount with pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.

2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections::
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 270500 – COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Summary
- B. Related Documents
- C. Reference Standards And Codes
- D. Administrative Requirements
- E. Work Results - Description Of Project
- F. Proposal Submittals
- G. Submittals For Project Record
- H. Equipment Relocation And System Startup
- I. Sequencing And Scheduling
- J. Quality Assurance - Contractor Qualifications
- K. Product Schedule
- L. Warranty
- M. Delivery, Storage, And Handling
- N. Product Quality Assurance
- O. Site Conditions
- P. Examination
- Q. Preparation
- R. Demolition / Removal
- S. Firestopping
- T. Construction Waste Management
- U. Labeling
- V. Closeout Activities

1.2 SUMMARY

- A. This document identifies the design and specification requirements for a complete and functional communications cable plant to be performed for the Owner. The communications cable plant as specified herein will support the voice, data, AV connectivity and various other low voltage signaling and control devices.
- B. The technology infrastructure will be compliant with the latest versions of the TIA/EIA 568-B Series Commercial Building Telecommunications Cabling Standards and the Owner's IT adopted cabling standards.
- C. The Architectural Plans and Specifications, General Conditions, Supplementary General Conditions and other requirements of Division 1, the Mechanical Plans and Specifications, the Electrical Plans and Specifications, and the Communications Plans may apply to the work specified in the Division 27 Sections, and shall be complied with in every respect. The Contractor shall examine all of these documents, which make up the Contract Documents, and shall coordinate them with all communications work on the Communications plans and in the Division 27 specifications.
- D. All work associated with Telecommunication and Equipment Rooms shall comply with the National Electrical Code, state and local building codes. The guidelines developed by ANSI/TIA/EIA and BICSI shall be followed in both design and construction.
- E. Contract Documents: Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general the specifications determine the nature and quality of the materials, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the communications system components. If there is an apparent conflict between the drawings and specifications, the items with the greater quantity or quality shall be estimated upon and installed. Clarification with the Owner, or their designated representative, about these items shall be made prior to bid response.
- F. The Architect may at any time, by written order, make changes within the general scope of any contract resulting from this proposal document. If such changes expand, reduce, change or modify the scope of work, the price for the change shall be increased or decreased at the unit prices set forth in the Unit Pricing Section, and the amount shall be deducted from, or added to, the sale price of the system to the Owner. No costs will be added to the project without prior written approval from the Architect.

1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 26 Grounding and Bonding
 - 2. 27 05 28 Pathways for Communications Systems
 - 3. 27 05 53 Identification for Communications Systems
 - 4. 27 11 00 Communications Equipment Room Fittings
 - 5. 27 13 00 Communications Backbone Cabling

6. 27 15 00 Communications Horizontal Cabling
7. 27 16 19 Patch Cords, Station Cords,& Cross-Connect Wire
8. 27 20 00 Data Communications Equipment
9. 27 30 00 Voice Communications Equipment

1.4 AGENCIES, REFERENCE STANDARDS AND CODES

A. Agencies

1. ANSI American National Standards Institute
2. BICSI Building Industry Consulting Service International
3. EIA Electronic Industries Association
4. FCC Federal Communications Commission
5. FOTP Fiber Optic Testing Procedures
6. IEEE Institute of Electrical and Electronic Engineers, Inc.
7. NBC National Building Code
8. NFPA National Fire Protection Agency
9. NEC National Electrical Code
10. TIA Telecommunications Industry Association
11. UL Underwriters Laboratories

B. Codes and Standards (Latest issue and addenda)

1. ADA Standards for Accessible Design 28 CFR Part 36
2. American Society for Testing Materials (ASTM)*
3. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard*
4. ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard*
5. ANSI/TIA/EIA-568-B.3 - Optical Fiber Cabling Components Standard*
6. ANSI/TIA/EIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces*
7. ANSI/TIA/EIA-606-A - Administration Standard for Commercial Telecommunications Infrastructures, June 21, 2002*
8. ANSI/TIA/EIA J-STD-607-A, Commercial Building. Grounding/Bonding Requirements-Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements

for Telecommunications, 2002*

9. ANSI/TIA/EIA-758-A - Customer-owned Outside Plant Telecommunications Infrastructure Standard, May 2005*
10. BICSI TDM, Cabling Installation, LAN Design, and Customer-Owned Outside Plant Manuals-Latest Editions
11. Chapter 208- State of Texas Communications Wiring Standard
12. International Standards Organization/International Electrotechnical Commission (ISO/IEC) IS 11801, 2000*
13. National Electric Code (NEC), Latest Issue
14. National Electrical Manufacturers Association (NEMA)*
15. OSHA - U.S. Department of Labor Occupational Safety & Health Administration
16. UL - Underwriters Laboratories (UL) Cable Certification and Follow Up Program*

C. Acronyms and Abbreviations

1. ADA Americans with Disabilities Act
2. AKA also known as
3. ANSI American National Standards Institute
4. AP access provider
5. ASTM American Society for Testing and Materials
6. AWG American Wire Gauge
7. BICSI Building Industry Consulting Services International
8. CATV community antenna television
9. CO-OSP customer owned outside plant
10. EF entrance facility
11. ER Equipment Room
12. EIA Electronic Industries Alliance
13. EMI electromagnetic interference
14. FCC Federal Communications Commission
15. HVAC heating, ventilation, and air conditioning
16. IEEE Institute of Electrical and Electronics Engineers

- 17. ITNO Information Technology Network Operations
- 18. ISO International Organization for Standardization
- 19. LAN local area network
- 20. Mb/s megabits per second
- 21. MC main cross-connect AKA Main Distribution Frame (MDF)
- 22. MDF main distribution frame AKA main cross-connect (MC)
- 23. NEMA National Electrical Manufacturers Association
- 24. NESCO National Electrical Safety Code
- 25. NFPA National Fire Protection Association
- 26. OFOI Owner Furnished Owner Installed
- 27. RCDD Registered Communications Distribution Designer
- 28. RFP Request for Proposal
- 29. RFO Request for Offer
- 30. SCS Structured Cabling System
- 31. TBB telecommunications bonding backbone
- 32. TR telecommunications room AKA Intermediate Distribution Frame (IDF)
- 33. TGB telecommunications grounding busbar
- 34. TMGB telecommunications main grounding busbar
- 35. TIA Telecommunications Industry Association
- 36. UL Underwriters Laboratories
- 37. UTP unshielded twisted-pair
- 38. WA work area
- 39. WAP wireless access points
- 40. X cross-connect

1.5 ADMINISTRATIVE REQUIREMENTS Coordination

A. Coordination

1. The Communications Cabling Contractor, here after referred to as "Contractor", shall provide all materials, components, tools and labor necessary for the complete installation

of all communications work required in the contract documents and specified herein.

2. The Electrical Contractor, here after referred to as “Electrical Contractor”, shall provide materials, components, tools and labor to complete a communications cabling pathway, electrical power distribution and communications building grounding system as set forth in the Structured Cabling System specifications and electrical specifications and T and E drawings.
3. Work furnished and installed by the Contractor as specified in Division 27 and as shown in E and T drawings includes:
 - a. The overhead cable runway system (ladder rack) within the new ER;
 - b. Identification for Communications Systems;
 - c. Communications Equipment Room Fittings;
 - d. Communications Backbone Cabling;
 - e. Communications Horizontal Cabling;
 - f. Patch Cords, Station Cords, and Cross-Connect Wire;
 - g. Coordination with OFOI Communications Services;
 - h. Coordination with OFOI Data Communications Equipment;
 - i. Coordination with OFOI Voice Communications Equipment;
4. Work under this Division not in contract (NIC) that will be Owner Furnished/Owner Installed (OFOI) includes:
 - a. Communications services;
 - b. Voice communications equipment;
 - c. Phone cords at the work area;
5. Work furnished and installed by the Electrical Contractor as specified in Division 27 and as shown in E and T drawings includes:
 - a. The conduits and back boxes for the work area telecommunications outlets.
 - b. Installation of the TMGB in the new ER;
 - c. Installation of the TBB from the new ER to the new TRs;
 - d. Installation of the Bonding Conductor for Telecommunications (BCT) that bonds the TMGB to the electrical power ground compliant with ANSI J STD-607 A Standards;
 - e. Bonding conductors from all cable tray, sleeves and conduits;
 - f. Electrical circuits in the telecom rooms.

6. Work furnished and installed by others.
 - a. Telecommunications room(s) walls shall be covered, floor to ceiling, with rigidly fixed $\frac{3}{4}$ " fire rated plywood, void free, and capable of supporting attached connecting hardware. Plywood should be covered with two coats of fire retardant paint per Section 27 05 53.
 - b. Fire walls shall be marked for easy identification and painted with two coats of fire retardant paint.

1.6 WORK RESULTS - DESCRIPTION OF PROJECT

A. Administrative Services

1. Contractor is required to provide test results and as-built documentation/record drawings prior to job acceptance.

B. Grounding and Bonding for Telecommunications

1. Provide and install a Telecommunications Grounding Busbar (TGB) in Telecommunications Rooms (TRs).
2. Provide and install a Telecommunications Main Grounding Busbar (TMGB) in building's Main Equipment Room (MER)/ER.
3. Bonding conductors from the TMGB or TGB will be installed to all communications terminating to equipment cabinets, equipment racks, raceway, cable ladder rack, cable tray, sleeves and conduits. Bond all TGBs to the TMGB per Section 27 05 26.
4. Bond TMGB to building ground per Section 27 05 26.
5. Final design and specifications for the Grounding and Bonding system shall be coordinated with the Electrical Engineer of Record.
6. Building entrance protection for copper cabling.
7. Grounding and Bonding for Communications described in Section 27 05 26.

C. Pathways for Communications Systems

1. The primary horizontal cable support system will be conduit to cablehooks. One inch (1") conduit servicing end users information outlets shall be "stubbed" to above the ceiling, and routed to the nearest corridor/hallway telecommunications horizontal cable tray pathway leading to the telecommunications room. Wall penetrations shall transition to properly firestopped sleeves, then back to cable tray.
2. Outlets having one single cable require a single gang box that routes to the cable tray via minimum one inch (1") conduit with pull string.
3. Outlets having two or more cables require a double gang box with a single gang reducer that routes to the cable tray via minimum one inch (1") conduit with pull string.
4. Conduit runs may not be longer than 100ft or contain more than two 90 degree bends between pulling points, pull boxes or reverse bends without the use of a properly sized

junction box. Insulated throat compression fittings must be used for communications conduit runs, with termination points having plastic or grounding bushings installed.

5. Riser sleeves in ER/TR must be properly installed with bushings and fire sealed. Initial sealing of the sleeve penetration is to be completed by the sleeve installer.
 6. Provide Shop drawings of all core drilling locations for coordination with Architect and Owner prior to drilling.
 7. All sleeves shall be reamed and grommets placed prior to cable installation to prevent cable damage.
 8. All telecommunications conduit shall be provided with a measured pull tape.
 9. Pathways for Communications described in Section 27 05 28.
- D. Identification for Communications All labeling will be compliant with TIA/EIA606-A - Administration Standard for Commercial Telecommunications Infrastructures as described in Section 27 05 53.
1. All labeling will comply with Owner administrative labeling scheme of cabling and its numerical positions on the termination hardware. Ensure compliance with Owner's preferred administrative labeling standards.
- E. Communications Equipment Room Fittings
1. The communications service entrance point is located in the Upper-level. The new service entrance pathway will consist of new (2) 4" conduit(s) from the ER through a new ductbank or existing tunnel system to existing Chemistry Building ER.
 2. Space for new outside plant fiber cable and terminating hardware will be provided in the ER.
 3. The new ER will be located on the upper level of the facility.
 4. Contractor shall provide each ER/TR with 19" floor mounted equipment racks installed per drawings. Equipment racks shall be properly bonded.
 5. Communications Equipment Room Fittings described in 27 11 00.
- F. Communications Backbone Cabling
1. Provide **24** strand, 9/125 micron single-mode fiber from Building ER to each Building TR.
 2. Provide **4** pair of vertical/horizontal copper backbone cabling consisting of 50- pair unshielded twisted pair Category 3 copper cables from the Main cross-connect field in ER to each TR rooms cross-connect field. Copper cable shall meet or exceed the mechanical and transmission performance specifications in ANSI/TIA/EIA-568-B.2 up to 16 MHz shall be installed.
 3. Copper cable shall be provided as required in NEC 2002; Listed Type CMR, CMP, MPR and/or MPP.

4. All copper backbone cables shall have a minimum 10ft service loop, and all fiber backbone cables shall have a minimum 20ft service loop.
5. Multi-mode outside plant fiber optic cable shall be provided for fire alarm connectivity only.
6. Communication Backbone Cabling requirements described in 27 13 00.

G. Communications Horizontal Cabling

1. All voice and data horizontal cables will consist of plenum rated, Category **6a**, 4 pair UTP copper cables terminated on 48 port RJ45 Category 6a, 568A patch panels in the ER/TRs. The maximum horizontal distance from the work station to the patch panel shall be 295 feet.
2. Communications Horizontal Cabling requirements described in 27 15 00.

H. Termination Hardware

1. All cable termination hardware shall be mounted in one of the Contractor provided and installed 19" racks – refer to E and AV-drawings for rack locations and counts.
2. Fiber backbone cabling shall terminate in, fully populated, rack mounted Fiber Panels using ST connectors and adapters.
3. Horizontal cabling shall terminate on rack mounted Category **6a** 48 port patch panels in the ER/TRs, and on RJ45 568A Category **6a** inserts at the outlet.

I. Patch Cords, Station Cords, and X-Connect Wire

1. Contractor shall provide two (2) Category **6a** patch cords per horizontal cable installed: 60% 5' length, 40% 7' length.
2. Contractor shall provide one (1) duplex fiber optic patch cords per fiber termination; patch cords shall be consistent with fiber type.
3. Contractor shall provide one (1) duplex fiber optic patch cords per fiber termination; patch cords shall be consistent with fiber and connector type. Lengths as required for neat and professional installation. Average length 10m. Coordinate with Owner prior to ordering.
4. All copper patch cords shall be installed in minimum one inch (1") plenum rated innerduct from cabinet to cabinet.

J. Data Communications Equipment

1. Data communications equipment will be OFOI.

K. Voice Communications Equipment

1. Voice communications equipment will be OFOI.

L. Network Connectivity for Other Trades:

1. Audio/Visual – Provide network connectivity as required for A/V elements. Refer to AV

drawings and specifications for details.

2. Electronic Safety and Security – Provide rough-in only as required facilitating voice and data network connectivity for IP cameras, Access Control Panels, etc. Refer to Security drawings and specifications for details. Security cameras and motion sensors are OFOI.
3. Fire Alarm – Provide copper/ fiber connectivity as required for Fire Alarm Panels.
4. Building Management System – Provide network connectivity as required facilitating operation of BMS/DDC.

M. Commissioning Administration

1. Contractor shall comply with General Commissioning Requirements of the technology infrastructure system.

N. Project Meetings

1. Contractor shall attend preconstruction meetings with Project Team.
2. Contractor shall provide representation on Project Team Meeting as specified in Division 1 and by the General Contractor as required.
3. Contractor will provide representation on the Commissioning Team as required for implementation of the Commissioning Plan.

O. Preconstruction Evaluation

1. Examination of buildings and site shall be the responsibility of the Contractor. Examine conditions for compliance with Communications design specifications. Validate Communications section is in accordance with related Contract Documents and the specified Owner's operational needs.

P. Construction Documentation

1. Contractor shall coordinate requirements with general provisions specified in Division 1 - Construction Progress Documentation.
2. Contractor shall provide weekly progress report including synopsis of previous week's completed tasks, list of ongoing work, and updated schedule addressing milestones. Also include items for Owner coordination.
3. Contractor shall provide weekly report of inspection by project RCDD to confirm Contractor's work is compliant with industry and manufacturer standards.

1.7 PROPOSAL SUBMITTALS

A. Contractor Certification:

1. Contractor shall be a licensed **Ortronics** Certified Integrator Design and Installation Company **or Belden CDT** capable of issuing a numbered registration certificate for the entire cable system. A copy of the Company certificate or verification by **Ortronics** or **Belden** records must accompany contractor bid, expired certificates and/or certificates issued under past certification programs will not be accepted. Proof of certification must

be included in proposal.

2. Submit written proof that the contractor is certified by the manufacturer of the products and adheres to the engineering, installation and testing procedures and utilizes the authorized manufacturer components and distribution channels in provisioning this Project.
 3. Contractor must be a member of Building Industry Consulting Services International (BICSI).
 4. 100 percent of on-site personnel shall have either **Ortronics** or **Belden** Certification in effect through, the bidding process, installation, testing, documentation, and acceptance. Documentation of all on-site personnel shall be provided post recommendation of selected contractor before final approval will be given.
 5. 100 percent of on-site installation personnel shall have BICSI certification in effect through the bidding process, installation, testing, documentation and acceptance. Documentation of all on-site personnel shall be provided post recommendation of selected contractor before final Owner's IT approval will be given.
 6. Contractor must have a minimum of one (1) Registered Communications Distribution Designer (RCDD) on staff, with Panduit approved Certification plus RCDD equivalent, submitted and approved by Panduit or Uniprise prior to project award. Submit a resume and copy of certifications for Contractor's RCDD.
 7. The RCDD shall provide approval on the design, installation, and documentation of communications system along with ensuring all Warranty documentation and requirements are met and submitted to **Ortronics** or **Belden** upon completion of the project. Documentation of all on-site personnel shall be provided before final Owner's IT approval is granted.
 8. Contractor shall not subcontract installation of voice/data/video cabling, termination or testing without the written consent of Owner and with **Ortronics** or **Belden's** review and confirmation to Owner of proposed subcontractor's current and valid certified status.
 9. Contractor shall have worked satisfactorily for a minimum of five (5) years on systems of this type and size.
 10. Design and Installation Certificates: Signed by local cable manufacturer's representative certifying that design is acceptable with cable manufacturer's Design Engineer(s) and Contractor is authorized by manufacturer to install registered (warranty) cabling system.
 11. A minimum of five (5) representative educational facilities cabling projects must be submitted as references to include the school's name, location, Architect or Engineer, cost of the cabling project and the contact person at the school district to include phone number.
 12. Upon request by the Owner, furnish a list of references with specific information regarding type of project and involvement in providing of equipment and systems.
- B. A list of technical product education (training) completed by the Contractor's project personnel.
1. All members of the installation team must be certified by the Manufacturer as having

completed the necessary training to complete their part of the installation. Submit resumes of the entire team and completed training courses and copies of BICSI Installer as well as **Ortronics** or **Belden's** training course certificates.

2. Submit cable tester manufacturer or a third party certification for copper and fiber cable test technicians.

C. Warranty

1. Unless otherwise specified, unconditionally guarantee in writing the materials, equipment, and workmanship for a period of not less than fifteen (15) years from date of acceptance.

D. Price Quotation Information -

1. Itemized Unit Pricing for Labor and Material;
2. Itemized Add/Deduct Unit Pricing for Labor and Material for Pre-Cutover (200' average length) FOUR (4) CAT 6a Drops;
3. Itemized Add/Deduct Unit Pricing for Labor and Material for Post-Cutover (200' average length) FOUR (4) CAT 6a Drops.

1.8 SUBMITTALS FOR PROJECT RECORD

A. Follow Division 1 and this Section.

1. Drawings: As-built documentation must be submitted five (5) business days prior to obtaining approval for cutover to any portion of the new cable plant system. Furnish for review and comments, 4 complete sets of E size (30 by 42) and 4 complete sets of C size as-built drawings along with 4 CDs containing all electronic AutoCAD 2000 or newer (DWG) files.
2. Submit project record drawings at conclusion of the project to include:
 - a. Final approved Shop Drawings
 - b. Plan drawings indicating location and identification of work area outlets, nodes, plan and elevation of telecommunication rooms, cable pathway details, and backbone cable type and locations and cable ID numbers.
3. 4 sets of cable inventory data must be submitted for all copper and fiber, termination hardware (prior to cutover to new cable plant if applicable.) Submit data in binders and electronically on CDs in "Microsoft Excel" format, listing products furnished, including:
 - a. Manufacturer's name and part numbers.
 - b. Cable numbers utilizing the Owner's cable numbering standard.
 - c. Telecommunication and Equipment Room termination detail sheets
 - d. Location and riser assignments.
 - e. Cross-connect schedules including entrance point, main cross-connects, intermediate and horizontal cross-connects.

- f. Labeling and administration documentation
 - g. Warranty documents for equipment
 - h. Copper certification test result printouts and diskettes
 - i. Optical fiber power meter/light source test results.
4. Manufacturer Certificates: Within 10 days of completion of the project, Contractor shall deliver letter signed by local Structured Cabling Components representatives and Contractor's RCDD stating that installed cabling system complies with all requirements specified in manufacturer's installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.
 5. Test Reports: 4 sets of hard copies with 4 copies on CD in compliance with related Test Result Documentation.
 6. Submitted test results and other submittals that are non-compliant will be reviewed and returned to the Contractor with comments.
 7. Re-submitted test results and other submittals that are non-compliant will be reviewed and returned to the Contractor with comments.
 8. Subsequent reviews of test results and other submittals will be performed jointly by the Contractor and the Communications Consultant and Contractor will pay Communications Consultant's published hourly rate during third review and thereafter.
 9. Manufacturer's warranty to the Owner. This shall include, but is not limited to: Owner's name and project name and address. (Within three weeks of substantial completion).
 10. Within 10 days of completion of the project, Contractor shall deliver letter signed by local SCS Manufacturers representative and Contractor's RCDD stating that installed cabling system complies with all requirements specified in installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.
 11. Within 21 days of completion of a project the communications contractor and/or the manufacturer's local representative will provide owner The Structured Cabling Performance Warranty signed by the manufacturer. The warranty shall list the owner and name of the Facility including location as the holder of the warranty.

1.9 EQUIPMENT RELOCATION AND SYSTEM

- A. Upon notice of construction completion, the selected Contractor will be responsible for system startup services for the new telecommunication room. The Contractor shall be responsible for ensuring the new equipment rooms, cabinets, floors and walls are clean and ready for equipment installation. On behalf of the Owner, the Contractor shall be responsible for coordinating with the GC and other trades to keep the ER and TRs clean and dust free at all times.
- B. It shall be the responsibility of the Contractor to develop and implement a full migration

project schedule detailing the responsibilities of assigned personnel, along with contingency plans, and submit it to the Owner, or their designated representative, for approval.

- C. During the transition period, Contractor shall have the necessary supervisory, technical, and other personnel available throughout technology relocations and cutover of the telephone, networking, and video systems. This is to ensure that technicians are on site to observe the operation and maintenance of the equipment, and to resolve any cabling related issues during system start-up.
- D. Contractor shall ensure all amenities are present prior to equipment relocation. Contractor shall immediately contact the Owner, or their designated representative, if a required service such as HVAC, electrical, UPS, etc., are not present.
- E. Contractor shall accomplish a smooth and successful transition of operations and services to the new telecommunication room. The transition includes the coordination, migration, testing, and problem resolution with the system vendors.

1.10 SEQUENCING AND SCHEDULING

- A. An initial planning meeting will be held with the successful bidder to clarify all requirements (systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that will transpire during the implementation of the project. Within two (2) weeks of the initial meeting, the Contractor shall provide a written report and project schedule to clearly document the events and responsibilities associated with the project.
- B. Contractor shall be responsible for the development and implementation of a complete project schedule detailing the responsibilities of assigned personnel and submit it to the GC and Owner for approval.

1.11 QUALITY ASSURANCE - CONTRACTOR QUALIFICATIONS

- A. Follow Division 1 and this Section.
- B. Voice/Data
 1. The installation company shall have a full-time RCDD on staff during all phases of the installation including testing and documentation. RCDD documentation shall be included in all responses to RFP/RFO.
 2. The Installer shall have either Uniprise **Ortronics** or Panduit **Belden** Certification in effect throughout installation, testing, documentation and acceptance.
 3. One hundred percent (100%) percent of on-site personnel shall be CommScope certified. The contractor's project manager or lead technician shall be BICSI certified to facilitate on-site installation practices and to provide inspections of on-going work.
 4. Untrained, undocumented, or otherwise unqualified personnel are not allowed to perform any portion of the communications infrastructure installation.
 5. All personnel must be permanent employees of the telecommunications contractor, or approved sub-contractors.

PART 2 PRODUCTS

2.1 PRODUCT SCHEDULE

- A. Refer to Division 27 sections for approved product and schedules.
 - 1. 27 05 26 Bonding and Grounding For Communications System
 - 2. 27 05 28 Pathways For Communications Systems
 - 3. 27 05 43 Underground Duct And Raceways
 - 4. 27 05 53 Identification For Communications Systems
 - 5. 27 11 00 Communications Equipment Room Fittings
 - 6. 27 13 00 Communications Backbone Cabling
 - 7. 27 15 00 Communications Horizontal Cabling
 - 8. 27 16 19 Patch Cords, Station Cords And Cross-Contact Wire
 - 9. 27 20 00 Data Communications Equipment
 - 10. 27 30 00 Voice Communications Equipment

2.2 WARRANTY

- A. A ~~2025-year CommScope~~ **Ortronics or Belden** Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided.
- B. The warranty covers all ~~CommScope~~ cables installed, tested and registered in a structured cabling system for a period of 20 years. A structured cabling system is defined as a cabling infrastructure, designed and installed to current ANSI/TIA/EIA-568-B series standards.
- C. The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568B and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.
- D. Unless otherwise specified, unconditionally guarantee in writing the materials, equipment, and workmanship for a period of not less than twenty (20) years from date of acceptance by Information Technology Network Operations.
- E. Warrant installation against all product defects, and that all approved cabling components meet or exceed the requirements of TIA/EIA-568B and ISO/IEC 11801 for a period of 20 years.
- F. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.
- G. Within 10 days of completion of the project, Contractor shall deliver letter signed by local SCS Manufacturers representative and Contractor's RCDD stating that installed cabling system

complies with all requirements specified in installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.

- H. Within 21 days of completion of a project the communications contractor and/or the manufacturer's local representative will provide owner The Structured Cabling Performance Warranty signed by the manufacturer. The warranty shall list the owner, name of the facility including location as the holder of the warranty.
- I. The Owner shall not be responsible for any aspect of ensuring the warranty is issued or updated. It shall be the Contractor's responsibility in conjunction with the Manufacturer.
- J. During the warranty period, Owner may engage any (manufacturer approved) communication contractor to perform future moves, adds and changes to the system. Owner approved contractors shall be responsible for updating any required documentation. Owner shall not be responsible for any aspect of updating and maintaining the warranty.
- K. The Labor, Material and Performance Warranty shall cover the testing and replacement of all structured cabling components. The structured cabling system shall be a complete certified system. The system and all components shall be performance matched and guaranteed by the manufacturer.
- L. Person / Entity Covered
 - 1. This warranty is for the sole benefit of Owner and any successor in interest to the site in which such Registered SCS was originally installed.
 - 2. All communications work and materials not included in the SCS components shall be warranted by the contractor that performed the work for a minimum of three years from the date of substantial completion.

2.3 DELIVERY, STORAGE, AND HANDLING

- A. Delivery Requirements: Follow Division 1 Requirements.
- B. Packing, Shipping, Handling, and Unloading
 - 1. Protect equipment during transit, storage, and handling to prevent damage, theft, soiling and misalignment.
 - 2. Coordinate with IT for temporary secure storage of equipment and materials during project timeframes.
 - 3. Do not store equipment where conditions fall outside manufacturer's recommendations for environmental conditions.
 - 4. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.
- C. Acceptance at Site
 - 1. All risk of damage or loss will remain with the Contractor until project completion and acceptance of the installation by the Project Manager. Upon acceptance, risk of loss will

pass to the Owner. Prior to that time, the Contractor shall be solely responsible for security of all Contractor provided project materials.

D. Storage and Protection

1. All materials and equipment delivered and placed in storage shall be stored with protection from the weather, humidity, and temperature variation, dirt, and dust, or other contaminants.
2. Material will be properly packaged in original factory-fabricated type containers and protected from damaging fumes, construction debris, and traffic until installation or job completion.
3. Any flammable materials or hazardous materials shall be kept and/or stored in suitable places approved by the General Contractor and outside the buildings at all times.

2.4 PRODUCT QUALITY ASSURANCE

- A. All materials and equipment provided shall be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufactures of such products. All materials shall be typical commercial designs that comply with the requirements specified. All materials and equipment shall be readily available through manufacturers and/or distributors. All equipment shall be supplied complete with any optional items required for proper installation.
- B. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to correct and make the cabling system work in compliance with the applicable manufacturer written technical recommendations and standards.

PART 3 EXECUTION

3.1 SITE CONDITIONS

A. Existing Site Conditions

1. Cable pathways and runs to individual outlets are not shown in their entirety but shall be provided as if shown in their entirety. The Contractor shall coordinate with other trades to determine exact routing.

B. Environmental Limitations

1. Due to the critical nature of the environment, the Contractor shall use extra effort to provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation. Contractor shall remove all rubbish from job site daily at his or her own expense.

C. Use of Site

1. Proceed with work without interfering with ordinary use of streets, aisles, passages, exits, and operations of the including Information Technology Network Operations.
2. Contractors will adhere to the Contractor Badge program and will wear assigned

contractor's badge on person in a clearly visible location following the Contractor Badge program standards as administered and provided by Facilities Planning & Construction.

3. Access to buildings where work is to be performed shall be directed by Information Technology Network Operations.
4. Contractors shall provide proper safeguards with personnel or appropriate safety barricades when pulling cables in any Owner's building or related off-site areas.

D. Continuity of Services

1. Previous arrangements must be made with the University representative to avoid interference with, or interruption of, existing building services. The work shall be arranged to minimize down time.

3.2 EXAMINATION

- A. Examination of buildings and site shall be the responsibility of the Contractor. Examine conditions for compliance with requirements of other sections in which related work is specified and determine if conditions affecting performance of the work of this Section are satisfactory. Do not proceed with work of this Section until unsatisfactory conditions have been corrected in an acceptable manner.
- B. Verify liquid-carrying pipes are not installed in or above voice and data system equipment rooms.
- C. Verify fire-rated backboards are properly installed and painted following Section 06105. Notify the Project Manager immediately and prior to installation in the event that the backboards are not installed or painted properly.
- D. Verify conduit, raceways, and boxes are properly installed.
- E. Prior to starting the installation, the assigned installation supervisor shall participate in a walk-through of the project site with the Project Manager to review the installation documentation, verify that all construction necessary for the installation has been completed, and verify all installation methods and cable routes.
- F. The Contractor shall provide a complete cabling infrastructure according to the written specifications and drawings. If the scope of work to be performed by the Contractor changes, it shall be in writing. Contractor shall respond to these changes with a complete material list, including pricing, labor, and taxes in writing per Division 1 requirements. Contractor shall not proceed with additional scope of work without signed approval by the General Contractor.

3.3 PREPARATION

A. Protection of Surroundings

1. Repair: Patching and repair of facilities, finishes, and equipment. Any damage to building or site caused by Contractor, including grass, paving, curbs etc., shall be restored at Contractor's expense to match condition prior to damage. If necessary and requested by the General Contractor, Contractor shall provide professional services to clean or repair scratched/soiled finishes at their own expense.
2. Contractor shall keep all foods and liquids (water, drinks, etc.) in designated break areas.

3. The Contractor shall obtain the Architect's and Engineer's written permission via the General Contractor before proceeding with any work necessitating cutting into or through any part of building structures such as girders, beams, concrete or tile floors, partition and/or ceilings.
4. If it becomes necessary to cut through any wall, floor, or ceiling to install any work under this Section of the Contract or to repair any defects that may appear up to the expiration of the guarantee period, such cutting shall be done by the Contractor under the supervision of the General Contractor.
5. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades caused by cutting or by the failure of any part of the work installed under this Contract, shall be performed by the appropriate trade but shall be paid for by the Contractor.
6. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically approved by the Architect/Engineer.
7. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.
8. Refer to Division 1 for additional information.

3.4 DEMOLITION/REMOVAL

- A. Unless indicated otherwise, all items that must be removed due to interference with work of this contract remain the property of the Owner, and are to be salvaged at the Owner's discretion. Any material to be salvaged, other than Contractor's waste material, must be approved in writing by the General Contractor.

3.5 FIRESTOPPING

- A. The Contractor is required to properly fire-stop any penetrations through fire barriers utilized for the placement of telecom cabling. Provide fire resistant intumescent materials to restore fire ratings to wall, floor, or ceiling penetrations according to local and national codes.
- B. Verify the hourly rating of the barrier.
- C. Select the UL Listing to match or exceed the barrier.
- D. Adhere to cable loads and fill procedure in the Listing.
- E. Seek pre-approval from the Authority Having Jurisdiction (Inspector).
- F. When installing the System, be sure not to exceed the listing limitations.
- G. After installation, place information labels and take digital photographs of both sides of each firestopped penetration in the System for future reference.
- H. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or

finishes.

- I. Provide fire resistant materials to restore fire ratings to all wall, floor, or ceiling penetrations used in the distribution and installation for communications cabling system. Coordinate fire stopping procedures and materials with General Contractor and Div.7.
- J. Solutions and shop drawings/submittals for fire stop materials and systems shall be presented to the General Contractor for written approval of materials prior to purchase and installation.
- K. Materials shall be installed per manufacturer instructions, be UL listed for intended use, and meet NEC codes for fire stopping measures.
- L. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and remain resilient and pliable to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.
- M. The fire stopping material shall maintain/establish the fire rated integrity of the wall/barrier that has been penetrated.
- N. Contractor shall coordinate with electrical contractor and ensure Communications Pathway firestopping is properly identified and labeled. Contractor shall laminate and permanently affix to each side of a fire wall/floor penetration, the following information:
 - 1. Installing Contractor's name, address and phone number.
 - 2. Alpha-numeric unique identifier (floor/penetration - A1)
 - 3. Name of manufacturer of fire stop system.
 - 4. Part & model numbers of system and all components.
 - 5. Phone numbers of manufacturer's corporate headquarters in U.S. and local distributor's name and phone number.

3.6 CONSTRUCTION WASTE MANAGEMENT

- A. Contractor shall remove all excess material and debris from the site upon completion of work each day and in a manner approved by the General Contractor's Project Manager. See Division 1.

3.7 LABELING

- A. Confirm administrative labeling scheme of cabling and its numerical positions on the termination hardware. Ensure compliance with Owner's preferred administrative labeling standards.

3.8 CLOSEOUT ACTIVITIES

- A. Acceptance shall be subject to substantial completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described herein.
 - 1. All Proposal Submittals and Project Record Submittals.

2. Training to Owner's representative on methods to add and remove fire stop barriers, add and remove isolation conduit seals and, when necessary, add and remove IP 67 rated outlets.
3. Maintenance manuals specified in Div. 1 to GC and Owner regarding structured cabling system, firestopping and conduit sealing methods and manufacturer's recommended maintenance instructions.
4. Contractor shall complete all punch list items within five (5) days of notification by GC.
5. Contractor shall wipe down all equipment, racks, cabinets, and sweep and mop ER/TR floors prior to Substantial Completion. Project will not be considered complete until cleaning has been done.
6. Contractor shall complete Closeout Checklist listing status of all submittals, maintenance manuals, Owner training, and punch list items and deliver per Division 1.

END OF SECTION 270500

SECTION 270526 – GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Work covered by this Section consists of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of grounding and bonding infrastructure as described on the Drawings and/or required by these specifications.

1.2 RELATED SECTIONS

- A. Refer to Section 27 05 00 for detailed information on scope of work.
- B. Refer to Section 27 05 53 for all labeling requirements.

1.3 DEFINITIONS

- A. MER - Main Equipment Room: The main room, which typically contains the PBX, MDF and main Data Communications equipment.
- B. ER - Equipment Room: Any additional room containing switches, hubs, patch panels and cross-connects away from a central location to serve areas out of distance from the MER.
- C. TO - Telecommunications Outlet: Point of connectivity for voice, data or video on the wall or in the floor. Refer to Telecommunications Drawings and Symbol sheet(s) for quantities and types of media at each outlet.
- D. MDF - Main Distribution Frame: A termination frame for unshielded twisted pair cable, usually providing a connection field for PBX telephone ports and feeder/riser cables to TR's. The MDF is normally located in the MER.
- E. IDF - Intermediate Distribution Frame: A termination frame for unshielded twisted pair cabling providing a connection field for horizontal wiring from the workstation and feeder/riser cables extended from the MER.
- F. TMGB - Telecommunications Main Grounding Busbar: The dedicated extension of the building grounding electrode system for the telecommunications infrastructure.
- G. TGB - Telecommunications Grounding Busbar: The grounding connection point for telecommunications systems and equipment in the area served by an ER.
- H. TBB - Telecommunications Bonding Backbone: A bonding conductor that provides direct connection between the TGB's and TMGB.

1.4 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

- D. Communication system grounding.
- E. Electrical equipment and raceway grounding and bonding.
- F. Control equipment grounding.

1.5 REFERENCES

- A. Follow Section 01423
- B. American Society for Testing and Materials (ASTM):
 - 1. B 3 Soft or Annealed Copper Wires
 - 2. B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
 - 3. B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 142-82 Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - 2. 1100 Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems.
- D. Underwriters' Laboratories (UL):
 - 1. 83 Thermoplastic Insulated Wire and Cables
 - 2. 96 Lightning Protection Components
 - 3. 96A System Installation
 - 4. 467 Grounding and Bonding Equipment
- E. National Fire Protection Association (NFPA):
 - 1. 780 Lightning Protection Code
 - 2. 70 National Electrical Code (NEC)
 - a. NEC Article No. 250 - Grounding
- F. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance (ANSI/TIA/EIA):
 - 1. J-STD-607-A Commercial Building Grounding and Bonding Requirements.
 - 2. Telcordia – Network Equipment Building Systems (NEBS) GR-1275.
- G. Building Industry Consulting Services International (BICSI):
 - 1. Telecommunications Distribution Methods Manual

2. Customer Owned Outside Plant Design Manual
- H. Local, county, state and federal regulations and codes in effect as of date of "notice to proceed" shall be complied with.

PART 2 PRODUCTS

2.1 GROUNDING BUSBARS

- A. Telecommunications Main Grounding Busbar (TMGB)
 1. Chatsworth #40153-020 ground busbar with Chatsworth busbar insulators or equivalent.
 2. Harger TMGB KIT (TGBI14420TMGBKT), or individual component
- B. Rack-mount Busbar
 1. Ortronics Grounding Strip (OR-GBH19KIT - horizontal, OR GBV72-vertical)
 2. Chatsworth Horizontal Rack Busbar, 19" (10610-019)

2.2 GROUNDING JOINTS AND SPLICES

- A. Grounding conductor joints/splices shall be mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor equal to Burndy "QPX", OZ/Gedney "XTP" or "PMX" or Penn-Union "VX" or copper compression type with two (2) indents equal to Burndy, T&B or Blackburn.
- B. Grounding conductor terminations (lugs) shall be single barrel, mechanical screw type, copper alloy with machined contact surfaces equal to OZ type "SL", T&B, or Burndy or copper compression type with two (2) indents equal to Burndy, T&B or Blackburn.

2.3 BONDING CONDUCTORS

- A. Cable Tray Bonding Conductor
 1. Green #8 AWG insulated bonding jumper (12" max) with appropriate lugs or manufactured braided copper grounding jumper equal to B-Line #CAM-GJ, T&B #BD12, OZ/Gedney type "FB" or Mono-Systems.
- B. Equipment Frame Bonding Conductor
 1. Panduit #TRGK672 Telecommunications Rack Grounding Kit.
- C. Bonding Conductor (BC)
 1. Green insulated copper bonding conductor, size as required by NEC.
 2. The BC shall be, as a minimum, the same size as the TBB.
- D. Telecommunications Bonding Backbone (TBB)

1. Green insulated copper conductor, minimum size of No. 6 AWG. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Insulation shall meet fire ratings of its pathway.

a. Table 1

1) Sizing of the TBB

2) TBB length (ft)	TBB Size (AWG)
(a) Less than 13	6
(b) 14-20	4
(c) 21-26	3
(d) 27-33	2
(e) 34-41	1
(f) 42-52	1/0
(g) 53-66	2/0
(h) Greater than 66	3/0

PART 3 EXECUTION

3.1 TELECOMMUNICATIONS INSTALLATION

A. Installation of the TMGB

1. Install the TMGB at the bottom of plywood backboard near the outside plant entrance conduits in the "MDF".
2. Contractor shall connect the TMGB to the grounding electrode conductor or to the electrical service or at the grounding electrode.
3. Conductor shall be installed in continuous 3/4" conduit.

B. Installation of the TGB

1. Install the TGB at the bottom of plywood backboard near the copper riser terminations in each "IDF".
2. TGB shall be installed so that the TBB for telecommunications is as short and straight as possible.

C. Installation of the TBB

1. Install Green insulated copper grounding conductor (refer to 2.03.D for conductor size) from the TMGB to each TGB.

D. Installation of Grounding Conductor Joints/Splices

1. Install mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor or copper compression type with two (2) indents.
2. Install manufactured insulating cover or heavy tape insulation over joints/splices.

E. Grounding of Cable Tray

1. Install Green #8 AWG bonding jumper (12" max) with appropriate lugs at each cable tray joint or install manufactured braided copper grounding jumper equal to B-Line #CAM-GJ, T&B #BD12, OZ/Gedney type "FB" or Mono-Systems.
2. Install Green #8 AWG grounding conductor with appropriate lugs from side of cable tray down to TMGB or TGB. Drill and tap side of cable tray (for appropriate size bolt, 1/4" x 20 min.), making sure that bolt does not extend into wire management part of tray.

F. Grounding of Equipment Frame

1. Install Panduit or equivalent Telecommunications Rack Grounding Kit from equipment frame to grounded cable tray, TMGB, or TGB.

END OF SECTION 270526

SECTION 270528 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior communications pathways and supports.
- B. Outlets and conduit runs.
- C. Risers in ER/TR(s).
- D. Grounding and bonding of pathways.
- E. Pathway fire stopping requirements.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 00 Common Work Results for Communications
 - 2. 27 05 53 Identification for Communications Systems
 - 3. 27 13 00 Communications Backbone Cabling
 - 4. 27 15 00 Communications Horizontal Cabling

1.3 SUMMARY

- A. This Section specifies the requirements for the Pathways for Communications
- B. Communication Pathways are defined to include, but are not limited to innerduct, conduit, pull boxes, sleeves, cable trays, supports, accessories, associated hardware and fire stopping materials.
- C. Final design and specifications for conduits shall be made by the Electrical Engineer of Record.
- D. Work furnished and installed by Electrical Contractor as specified in this Section and as shown in E drawings includes:
 - 1. The conduits and back boxes for the work area telecommunications outlets.
 - 2. The floor poke through hardware.
 - 3. Fire stopping of cable tray and conduit cable pathway
- E. Work furnished and installed by the Cable Contractor as specified in this section and as

shown in E drawings includes:

1. The overhead cable runway system (ladder rack) within the new ER.
 2. Bonding and grounding of overhead cable runway system (ladder rack), racks and cabinets within the ER/TR.
- F. The primary horizontal cable support system will be cable tray, installed as shown in T drawings. Cable tray will be properly grounded. Wall penetrations shall transition to properly firestopped 1"- 4" sleeves, then back to cable tray.
- G. Outlets having one single cable require a single gang box that stubs up into the ceiling void via one (1) 1" conduit with pull string. Use of flexible conduit is expressly discouraged.
- H. Outlets having two or more cables require a double gang box with a single gang reducer that stubs up into the ceiling void via one (1) 1" conduit with pull string.
- I. Conduit runs may not be longer than 100ft or have more than two 90 degree bends without the use of a properly sized junction box. Insulated throat compression fittings must be used for communications conduit runs, with termination points having plastic or grounding bushings installed.
- J. Cable tray is being provided in the IT Room only.
- K. Minimum radii for conduit bends shall be as follows:
1. Internal diameter of less than two (2) inches is 6 times the internal diameter.
 2. Internal diameter of more than two (2) inches is 10 times the internal diameter.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Pathways:
1. J-Hooks: Panduit
 - a. J-Pro
- B. Cable Tray: Cablofil
1. 12" x 2" – CF54 /300 EZ
 2. 12" X 4" – CF105 / 300 EZ
- C. Cable Tray: GS Metal Corp: www.flextray.com
1. FEXTRAY Cable Management System
- D. Ladder-Type Cable Tray: Chatsworth
1. Formed aluminum or sheet steel painted with gray epoxy

2. Straight section rung spacing: 6 inches on center

2.3 CABLE HOOK SYSTEMS

- A. J-hooks shall be installed 4ft to 5ft apart. Uniform spacing should be avoided to minimize problems with signal degradation.
- B. J-hooks shall be supported from decking or building structure using methods approved by the manufacturer.
- C. Cable count shall not exceed manufacturer's recommended maximum. Add separate parallel J-hook pathway when cable count requires it.

2.4 CONDUITS AND FITTINGS

- A. For each communication outlet indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.
- B. See SECTION 26 05 33 - RACEWAYS, CONDUITS AND BOXES
- C. Minimum conduit size for Telecommunications Outlets shall be 1 (one) inch.

2.5 WALL AND CEILING OUTLET BOXES

- A. All wall outlets shall be mounted in a minimum four (4)-inch by four (4)-inch by two and one-half (2 1/2)-inch deep double gang outlet box with a single gang mud-ring.
- B. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

2.6 PULL / JUNCTION BOXES

- A. Pull boxes used with telecommunications conduits in interior locations shall be rated NEMA- 1. Pull boxes used in damp or wet locations such as plumbing chases or out of doors shall be rated NEMA-3R. Pull boxes shall be installed in conduits run at an interval no greater than every 100 feet. A pull box shall be installed in conduit runs whenever there are two 90°sweeps, or a total of 180°of sweeps, in a conduit run. A pull box may not be used to change the direction of a conduit run. Any deviations from these criteria must have prior approval from UH Information Technology.

2.7 PLENUM RATED FIBER OPTIC INNERDUCT

- A. All fiber shall be installed in 1 ¼" corrugated, non-metallic plenum rated innerduct when not installed in conduit or in utility tunnel tray.
 - 1. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.
 - 2. Only manufacturer's fittings, transition adapters, terminators and fixed bends shall be used.

B. Products

1. White or orange, plenum rated, UL Listed, flexible optical fiber/communication raceway.
2. Recognized per NEC Articles, 770 and 800 for plenum areas for optical fiber and telecommunications cables.
3. Provide all fittings to form a complete integrated raceway system.

C. Fabrication

1. Footage shall be sequentially marked.

2.8 CABLE TRAY SECTIONS AND COMPONENTS

- A. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- B. Tray Sizes shall have 4 inch minimum usable load depth, or as noted on the drawing.
- C. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 12 foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
- D. Tray widths shall be twelve (12) inches or as shown on drawings.
- E. All fittings must have a minimum radius of 24 inches.
- F. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
- G Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span indicated on drawings. Supports shall be constructed from 12 gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits (9G-55XX-22SH) as manufactured by Cooper B-Line, Inc. or engineer approved equal. Cable trays installed adjacent to walls shall be supported on wall mounted brackets such as B409 as manufactured by Cooper B-Line, Inc. or engineer approved equal.
- H. Trapeze hangers shall be supported by 1/2 inch (minimum) diameter rods.
- I. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.
- J. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

PART 3 EXECUTION

3.1 SUMMARY

- A. Final design and specifications for the Communications Systems conduits shall be made by the Electrical Engineer and Architect of record.
- B. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. No conduit shall be less than 1".
- C. Conduits entering the Telecommunications Room shall be located allowing for the most flexibility in the routing and racking of cables.
- D. Conduits between Building Telecommunication Rooms shall be four (4) inches.
- E. Conduits or conduit sleeves entering through the floor of the Telecommunications Room shall terminate two (2) inches above the finished floor. The outer diameter of the conduit shall be located within four (4) inches of room walls.
- F. All metallic telecommunications conduits entering the Telecommunications Room, Equipment Room, or Entrance Facility shall be bonded together, and bonded to the Telecommunications Main Grounding Busbar with a #6 AWG ground cable.
- G. Conduits shall be installed in the most direct route possible from the Telecommunications Room to the work area.
- H. Conduits shall not be run next to hot water lines, steam pipes, or other utilities that may present a safety hazard or cause a degradation of system performance.
- I. All in-use and spare conduits entering the Telecommunications Room, Equipment Room, or Entrance Facility shall be sealed to prevent the intrusion of water, gasses, and rodents throughout the construction project. Within five days of releasing the conduit for the installation of cable, the conduit installation contractor shall prove all conduits to be clean and dry.
- J. All conduits and cables that penetrate fire rated walls or floors must be fire stopped.
- K. Cables shall be neatly dressed along common paths with Velcro tie wraps with voice cables separated from data cables. Maximum number of cables per bundle shall not exceed manufacturer specifications.
- L. Layout cable pathway runs in advance to determine space requirement along pathways, and to ensure non-interference from other trade installations.
- M. Do not support communication pathway from, or lay on, ceiling suspension system or use electrical, plumbing, or other pipes for support. Communication pathway supports shall be permanently anchored to building structure or joist.
- N. Provide attachment hardware and anchors designed for the structure to which attached, and that are suitably sized to carry the weight of the pathway and cables to be supported. Confirm with architect and/or construction manager on installation procedures for cable support system prior to implementation.
- O. Conduits shall be reamed to eliminate sharp edges. Metallic conduit shall be terminated with an insulated bushing. Initial sealing of the sleeve penetration shall be completed by the

sleeve installer. Refer to ANSI/TIA/EIA-606 and Section 27 05 53 for administration of the pathway system.

- P. The inside of the cable tray or wireway shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) shall have the portion within the tray protected with a smooth, non-scratching covering so that cable can be pulled without physical damage. When a wireway passes through a partition or wall, it shall be an unbroken length. Installation of telecommunications cables shall not exceed the fill requirements. Openings in fire-rated walls, floors and ceilings shall be properly firestopped. Barriers between power and telecommunications cables shall be installed per electrical code. Cable trays and wireways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.
- Q. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the applicable class as specified in the electrical code. A support should be placed within 600 mm (2 ft) on each side of any connection to a fitting. Wireways shall be supported on 1500 mm (5 ft) centers unless designed for greater lengths.
- R. A minimum of (12 in) access headroom shall be provided and maintained above a cable tray. Care shall be taken to ensure that other building components e.g., air conditioning ducts) do not restrict access to trays or wireways.

3.2 MINIMUM CLEARANCES

- A. Communication Pathway minimum clearances from:
 - 1. Minimum of 1 foot parallel, 3 inches crossover from power cables and conduits.
 - 2. Minimum of 6 inches above ceiling tiles.
 - 3. Minimum of 24 inches Hot Flues, Steam pipes, Hot water pipes and other hot surfaces.
 - 4. Minimum of 3 feet separation from electrical panel boards.
 - 5. Minimum of 5 inches from fluorescent fixtures.
 - 6. Minimum of 6 feet separation from electrical motors and transformers.
 - 7. Minimum of 2-inches from exposed all-thread rods.

3.3 FIRE STOPPING

- A. Provide fire resistant materials to restore fire ratings to all wall, floor, or ceiling penetrations used in the distribution and installation for communications cabling system. Coordinate fire stopping procedures and materials with General Contractor and Electrical Contractor.
- B. Solutions and shop drawings/submittals for fire stop materials and systems shall be presented to the General Contractor for written approval of materials prior to purchase and installation.
- C. Materials shall be installed per manufacturer instructions, be UL listed for intended use, and meet NEC codes for fire stopping measures.

- D. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and remain resilient and pliable to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.
- E. The fire stopping material shall maintain/establish the fire rated integrity of the wall/barrier that has been penetrated.
- F. Cable Contractor shall laminate and permanently affix to the MDF wall, adjacent to chases, the following information:
 - 1. Name of manufacturer of fire stop system.
 - 2. Part & model numbers of system and all components.
 - 3. Phone numbers of manufacturer's corporate headquarters in U.S. and local distributor's name and phone number.

END OF SECTION 270528

SECTION 270536 – CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

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. Ladder cable trays.
2. Wire-mesh cable trays.
3. Single-rail cable trays.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 2. Vertical and horizontal offsets and transitions.
 3. Clearances for access above and to side of cable trays.
 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 2. Component Importance Factor: 1.5.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAYS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Legrand/PW; Ladder Cable Trays or comparable product by one of the following:
1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 2. Chalfant Manufacturing Company.
 3. Cooper B-Line, Inc.
- B. Description:
1. Configuration: Two side rails with transverse rungs welded to side rails.
 2. Rung Spacing: 12 inches (300 mm).
 3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
 4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
 5. No portion of the rungs shall protrude below the bottom plane of side rails.
 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
 7. Minimum Usable Load Depth: 6 inches (150 mm).
 8. Straight Section Lengths: 10 feet (3 m except where shorter lengths are required to facilitate tray assembly).
 9. Width: 12 inches (300 mm unless otherwise indicated on Drawings).
 10. Fitting Minimum Radius: 12 inches (300 mm).
 11. Class Designation: Comply with NEMA VE 1, Class 12B
 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
 13. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316

2.4 WIRE-MESH CABLE TRAYS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Legrand/Cablofil; Wire Mesh Cable Trays or comparable product by one of the following:
1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 2. Chalfant Manufacturing Company.
 3. Cooper B-Line, Inc.
- B. Description:
1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
 2. Materials: High-strength-steel longitudinal wires with no bends.
 3. Safety Provisions: "T" weld wire ends along wire-basket sides (flanges) during manufacturing to maintain integrity of cables and installer safety.
 4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch (3000-mm) lengths.
 - b. Wire-Mesh Depth: 6 inches (150 mm wide).
 - c. Wire-Mesh Depth: 4-inch (100-mm) usable loading depth wide.
 - d. Wire-Mesh Depth: 6-inch (150-mm) usable loading depth wide.
 5. Connector Assemblies: Listed snap-in couplers or factory assembled bolted couplers that mechanically join adjacent tray wires to splice sections together or to create horizontal fittings.
 6. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316

2.5 MATERIALS AND FINISHES

- A. Steel:
1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33
 2. Steel Tray Splice Plates: ASTM A 1011/A 1011M.
 3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 4. Finish: Mill galvanized before fabrication.
 - a. Standard: Comply with ASTM A 653/A 653M, G90 (Z275).
 - b. Hardware: Galvanized, ASTM B 633

5. Finish: Electrogalvanized before fabrication.
 - a. Standard: Comply with ASTM B 633.
 - b. Hardware: Galvanized, ASTM B 633.
 6. Finish: Hot-dip galvanized after fabrication.
 - a. Standard: Comply with ASTM A 123/A 123M, Class B2.
 - b. Hardware: Chromium-zinc plated, ASTM F 1136
 7. Finish: Epoxy-resin paint.
 - a. Powder-Coat: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - b. Hardware: Chromium-zinc plated, ASTM F 1136
 8. Finish: Factory-standard primer, ready for field painting, with zinc-plated hardware according to ASTM B 633.
- B. Aluminum:
1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 5052-H32
 2. Hardware: Chromium-zinc-plated steel, ASTM F 1136Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA FG 1.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use rib neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- I. Support bus assembly to prevent twisting from eccentric loading.
- J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- K. Locate and install supports according to NEMA FG 1. Do not install more than one cable tray splice between supports.
- L. Support wire-basket cable trays with trapeze hangers.
- M. Support trapeze hangers for wire-basket trays with 1/4-inch- (6-mm-) diameter rods..
- N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- P. Make changes in direction and elevation using manufacturer's recommended fittings.
- Q. Make cable tray connections using manufacturer's recommended fittings.
- R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- S. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- T. Install cable trays with enough workspace to permit access for installing cables.
- U. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- D. Cable trays with powder-coat paint should have coating mask completely removed at factory supplied grounding location and splice with listed connectors as recommended by manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 7. Check for improperly sized or installed bonding jumpers.
 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

270543 – UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 31 81 26 - Communications Underground Ducts, Manholes, and Handholes
- B. This Section includes earthwork information in the absence of Division 31 specifications. Conflicts between this section and Division 31 specifications shall be resolved by the architect/engineer / designer in consultation with Owner.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. IEEE C2 - National Electric Safety Code.

1.3 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.4 SAFETY AND RESTRICTIONS

- A. See specific elements within this document for safety and restrictions information. Contractors shall bear all responsibility and cost to locate existing underground utilities including, but not limited to, electricity, natural gas, domestic water, steam and condensate, chilled water, sewer, storm drainage, and telecommunications. Most of these utilities are owned and maintained by the Owner. In many cases, utilities have been plastic pipe without metallic (detectable) elements. Contractors shall have all underground utilities clearly marked prior to any excavation.
- B. Maryland's Underground Facilities Protection Organization, or Miss Utility, shall locate utilities within the boundaries of the Owner. Locate contractors shall be pre-approved by the Owner.
- C. Contractors shall contact the Owner immediately if unmarked utilities are discovered. Contractors shall stop all work in the area until the utility can be identified by the Owner. Contractors may be required to recall the originally pre-approved locator to trace the utility to an identifiable point. Contractors shall contact the Owner immediately if a utility is damaged in any way. Contractors shall stop all work in the area until directed by the Owner.
- D. Areas of the campus are restricted from heavy equipment, including but not limited to backhoes, concrete trucks, utility and work trucks, and other full-size vehicles. Contractors shall contact the Owner's Personnel for specific restrictions based on the location of the work area.
- E. During construction of all pathways, the Owner's Security shall determine if closures of the Owner's-controlled roads or spaces are possible at proposed dates and times. When on the Owner's property, Contractors shall coordinate all activities with interested parties.
- F. Locating done by another trade or a general contractor in the same work area and for the same overall project does not need to be repeated by the Contractors, provided 1) the entire cabling work area was recently covered, 2) the markings are bold and undisturbed, and 3) the geographic scope of the work area can be confirmed by the locating company.

- G. Information on underground utility placement does not waive Contractors from confirming the presence and location of all underground utilities in the work area.
- H. There are no specific safety information or restrictions for direct-buried pathways.
- I. Contractors shall provide all necessary equipment to safely excavate and construct conduit/duct pathways. Contractor shall comply with all federal, state, and the Owner's regulations regarding working in this environment. Appropriate personal protective equipment is required and shall be the responsibility of the Contractors.
- J. Contractors shall provide all necessary equipment to safely excavate and construct tunnel penetrations. Contractor shall comply with all federal, state, and the Owner's regulations regarding excavation and working in this environment. Personal protective equipment is required and shall be the responsibility of the Contractors.
- K. See Section 27 00 00: Communications General.

1.5 DESIGN REQUIREMENTS

- A. New construction or other circumstances may require the relocation of existing OSP elements. Relocating OSP elements requires improving those elements to meet current codes, standards, methods, and specifications.
- B. During the relocation of OSP elements, services provided by or through the elements shall be minimally impacted. Service outages are to be minimal and during off-hours. Extra effort may be required to accommodate the service users (e.g. using half-taps on a replacement voice backbone cable). All service outages must be pre-approved by the Owner's Personnel.
- C. The location of pathways shall be coordinated with the Owner's Personnel early in the design process. Pathways should anticipate future campus growth with respect to placement and sizing. Pathways are likely to be oversized for a given project where the pathway is in a growth area or may have a foreseeable additional use.
- D. Pathway design shall avoid older, established trees. In very rare cases, small ornamental trees that can be moved or replaced may be so treated with prior approval. Planting beds and shrubs can be disrupted as needed, provided they are fully restored to original condition.
- E. Walkways and roadways can be crossed as needed, provided there is full restoration. Empty conduits have been placed under newer brick walkways to minimize walkway disruption. Designers should consult with the Office of Facilities Management to review existing site plans to locate these conduits.
- F. Where possible, new conduits installed along the same pathway as an existing pathway shall be installed as part of the existing ductbank. This physical arrangement minimizes the campus area occupied by network ductbanks. Designers may design intercepting and accessing these existing pathway elements. Designers may expose the existing ductbank and use its vertical side to frame the space for the new conduits.
- G. Security devices (alarms, sensors, cameras, etc.) may require dedicated cabling to specific, non-standard locations. These devices will be designed as required and may run independent of other pathways and requirements for this document. The Owner's Personnel shall approve all pathway designs involving security or life-safety cabling.
- H. Underground Pathways
 - 1. Underground conduit structures are pathways used for placing network cable between

access points such as MHs, HHs, HBs, and building entrances. Cable pathways should be underground, where possible. Underground pathways should be concrete-encased conduit, where possible. Special pathways may use conduits without concrete encasement or with the installation of a concrete cap. Clearances as required by NESC.

2. The conduits and fittings shall be a 4" ID PVC SCH 40. The conduits shall have bell ends and shall be joined with the appropriate adhesive for this type of conduit providing a permanent and watertight seal.
3. The diameter of a duct shall be at least 1.15 times the diameter of the cable, or one-half trade size larger in diameter than the diameter of the largest anticipated cable (whichever provides the greater clearance).
4. Underground pathways shall be designed for as minimal depth of 30" to the top of the pathway elements, where possible. Deviations from this shall be pre-approved by the Owner's Personnel. Pathways may gradually slope up to 30" deep to enter HBs or HHs.
5. Design underground conduit elevations so that a slope exists at all points of the run to allow drainage. A drain slope toward the MH of no less than one percent grade is desirable.
6. Design for an aggregate bed of a minimum of 12 inches of compacted aggregate, under the same guidelines as MH installation, for the first 6 feet of any ductbank exiting a MH.
7. Design for conduit spacers beneath each conduit three times for every 20 linear feet of conduit with an additional support at the end. The spacers shall be evenly distributed over each 20 foot segment (e.g. one at each 20 foot joint and two evenly spaced over the middle). Each horizontal row of spacers (in cross-section) shall be designed with a 6" minimum horizontal distance from any other row of spacers so as to eliminate weak vertical shear planes.
8. Design conduit formations to facilitate orderly cable racking within the MH and ensure minimal change in the formation when entering a MH. The following recommendations allow for the design of the most efficient cable formation.
 - a. The main conduit formations should enter the end walls of the MH at a point approximately halfway between the floor and roof.
 - b. For wall racking considerations, design splayed ductbank entrances at the end walls rather than center placement.
 - c. If the total number of conduits being places is significantly less than the capacity of the terminating MH or cable entrance, conduits should enter at the lower level. The upper space should be reserved for future conduit additions.
 - d. The conduit entrance into the MH should be sized for the ultimate number of conduits to prevent the need for future wall breakouts.
9. Refer to the current BICSI CO-OSP manual for conduit bend radii. Curved sections shall be pre-manufactured. Curved segments shall have minimum of 15 ft radii. Sweeps to enter utility tunnels may be less. Any sweep below 15 ft radius shall be pre-approved by the Owner's Personnel.
10. Ductbank configuration shall vary, depending on the spaces into which the conduits end.
11. All buildings shall have a minimum of four 4-inch conduits accessing the entrance facility.

Two shall include multi-cell pathway with a minimum of three factory-manufactured inner cells.

12. Compacted aggregate to be used to backfill may be crushed stone or gravel fill provided the percent composition by dry weight as determined by laboratory sieves (U.S. series) conforms to the following grading when measured in accordance with ASTM C136-01 (Test Method C136-01 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates):
13. Lesser-grade material to be used to backfill. This backfill material may be material removed from the original excavation. All backfill materials shall be free from boulders, large rock, asphalt, concrete, bricks, wood blocks or roots, and other debris. High quality top-soil shall be used.
14. Match sod of the same origin as the surrounding area.
15. Design for all materials to prevent erosion of seeded areas.
16. The Owner shall approve materials necessary to minimize erosion and soil run-off.
17. Design for a level layer of compacted aggregate over each encased ductbank. The bed shall extend 1 foot above the surface of the ductbank. The first 6 inches of the aggregate bed shall be compacted to not less than 95% density compared to maximum laboratory tests by weight per ASTM D1557-64T method. A. The second six inches of the aggregate bed shall be compacted to not less than 85% density compared to maximum laboratory tests by weight per ASTM D1557-64T, method A.
18. Horizontal conduits shall end flush with the interior surface of the wall. Vertical conduits ending in eaves shall be designed such that they extend a minimum of 4" above the final floor. Cut the conduits square with the conduit and not necessarily level to the floor. Bushings shall be installed on conduit ends.
19. 4" compression-type duct plugs (Condux, Nonmetallic Eye Nut Plug- 08067840), or equivalent., Universal or "push-in" type plugs (e.g. Condux, Universal Plug- 08047601) are not an acceptable substitute.
20. Provide 1¼" OD nonmetallic flexible raceway (innerduct) with smooth exterior surface. Provide 1¼" OD corrugated nonmetallic flexible raceway (innerduct). All innerduct shall be orange.
21. Install warning tape to be provided by the Owner (Empire Level Mfg. Corp. 25 071 Orange FO cable MegaStretch Underground Marking Tape) or equivalent.
22. Provide #10 copper, green insulated tracer wire.
23. Specify the installation of 3/8" or greater Neptco Polyester Muletape pull strings.
24. Once built, the conduit system should remain usable for 75 to 100 years and fulfill design specifications.

I. Encasement

1. When fully encasing in concrete, 4" ID PVC type EB-35 conduits and fittings are acceptable. The conduits shall have bell ends and shall be joined with the appropriate adhesive for this type of conduit providing a permanent and watertight seal.
2. Ductbanks shall be designed to be encased in concrete. All interbuilding pathways shall

be encased. The concrete shall be 3/8" aggregate with a nominal compressive strength of 3000 PSI. Concrete surrounding the conduits shall be at least 3 inches around all sides of the conduit for complete encasement.

3. Fully encase any ductbanks that penetrate a MH or building for the first 6 feet beyond the structure.
4. When transitioning from an encased ductbank to a capped ductbank, it is not necessary to frame the transition in cross-section, provided the required area is encased to a minimum of 3 inches. The concrete may slope down into the area to be capped. If framing a transition point, the frame shall be removed prior to installing aggregate around the conduits and installing the cap.
5. Shape the top of the concrete in such a way as to slope water away from the ductbank-structure seams.
6. Design for steel reinforcing bars, vertically and horizontally, to form a vertical box framing the conduits. The vertical bars shall be driven a minimum of 6 inches deep to prevent the conduits from floating during concrete pouring. The horizontal bars shall be secured to the vertical bars to prevent movement. The vertical bars shall extend 3 inches above the top conduit row. Alternately, the bars may be less than 3 inches above the top conduit row, if an inverted spacer is placed on the top row to provide a 3 inches depth gauge for pouring concrete.
7. The design may use "U"-shaped bars to straddle the conduits, if driven into the trench as specified above. The design may use a single horizontal bar or an upward pointing "U"-shaped bar in this configuration. The upward pointing "U"-shaped bar shall extend 3 inches over the top conduit or use an inverted spacer to provide a 3 inch depth gauge for pouring concrete.
8. Design for reinforcing bars, longitudinally. The bars shall be secured to each vertical reinforcing bar box. The longitudinal bars shall overlap 12 inches, unless welded together, and shall be secured to each other in a way to prevent movement.

J. Capping

1. Designers may propose a "capped" ductbank for certain pathways. These pathways may include parking lift gate cable or other low count cables to specific field devices. When capping a ductbank, install filler sand around the conduits providing at least 3 inches of sand below and to the side of all conduits. Filler sand above the top of the conduit ductbank shall not be allowed.
2. Design the filler sand to fill to the side walls of the trench. Compact filler sand to the sides of the conduits.
3. The design may allow for framing on the compacted surface of the sand for pouring the concrete cap.
4. Design for a 3 inch thick concrete cap over the conduits.
5. Extend the cap horizontally to a minimum of 3" beyond the outer most conduits.
6. If the cap is framed, the design may show lesser-grade backfill material to cover the sand beyond the cap once the framing is removed.

K. Non-encasement

1. In special circumstances, the design may plan for conduits installed without concrete. These installations may include parking lift gates, information kiosks, and other non-critical devices as determined by the Owner's Personnel.

L. Existing Ductbanks

1. The designers may use conduits and/or innerducts within existing ductbanks as directed by the Owner's Personnel. Where possible, used conduits with available innerducts or space shall be used.

M. Existing Ductbanks

1. The designers may use conduits and/or innerducts within existing ductbanks as directed by the Owner's Personnel. Where possible, used conduits with available innerducts or space shall be used.
2. When designing optical fiber into a 4" conduit without existing innerduct or cable, design for three 1-1/4" OD innerducts.
3. When designing for a 200 pr. copper cable, or less, design for two 1 - 1/4" OD innerducts with the cable. Design for one 1 - 1/4" OD innerduct for larger copper cables, if possible.
4. The design shall specify ribbed innerduct. Corrugated innerduct may be used only when necessary to make tight bends and then only as much as needed before making a transition to ribbed innerduct.
5. Specify Muletape in all innerducts.
6. Specify pre-formed duct plugs around innerducts and smaller compression-type duct plugs in the innerducts.
7. Seal used conduits (when pre-formed plugs are not feasible) with a non-hardening, removable sealant (PT Tech DuckSeal Sealant). Expanding foam products designed specifically for duct sealing (e.g. 3M Part #4416 Duct Sealant Kit) may only be used on conduits considered to be at capacity by the Owner's Personnel. Innerducts shall not extend beyond six inches from the end of the conduit.

N. Direct-buried

1. Direct-buried pathways shall not be used. All pathways shall include the use of conduit.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Store all materials under cover and elevated above grade. Prevent water, dirt, and debris from entering conduits and tubing.

PART 2 PRODUCTS

2.1 MATERIALS

A. Conduits

1. Manufacturers
 - a. IPEX, Inc.: TerraCon PVC raceway for directional boring and open trenching

- b. Carlon: PVC Bore-Gard for directional boring and open trenching
- 2. PVC SCH 40
 - a. Manufactured to NEMA TC2 (Electrical Polyvinyl Chloride (PVC) Tubing and Conduit) specifications
 - b. Bell ends
 - c. Appropriate adhesive for this type of conduit providing a permanent and watertight seal
- 3. PVC SCH 40 Fittings
 - a. Manufactured to NEMA TC3 (PVC Fittings for Use with Rigid PVC Conduit and Tubing) specifications.
 - b. Appropriate adhesive for this type of fitting providing a permanent and watertight seal
- 4. PVC SCH 40 Pre-Manufactured Sweeps
 - a. 6 ft radius, 90 degree sweeps
 - b. 45 degree sweeps of >6 ft radius
- 5. PVC type EB-35
 - a. For use only when fully encased in concrete
 - b. Manufactured to NEMA TC8 (PVC Plastic Utilities Duct for Underground Installations) specifications
 - c. Bell ends
 - d. Appropriate adhesive for this type of fitting providing a permanent and watertight seal
- 6. PVC type EB-35 Fittings
 - a. For use only when fully encased in concrete
 - b. Manufactured to NEMA TC9 Fittings for PVC Plastic Utilities Duct for Underground) specifications
 - c. Appropriate adhesive for this type of fitting providing a permanent and watertight seal
- B. Conduit Spacers
 - 1. Manufacturers
 - a. Underground Devices, WUNPEECE spacers- 4W20-2
 - b. Other acceptable manufacturers offering equivalent products
- C. Conduit plugs
 - 1. Compression-type plug
 - 2. Manufacturers

- a. Condux, Nonmetallic Eye Nut Plug- 08067840
 - b. Other acceptable manufacturers offering equivalent products
 3. Universal or "push-in" type plugs (e.g. Condux, Universal Plug- 08047601) not acceptable
- D. Conduit Seals
1. Non-hardening, removable sealant- PT Tech DuckSeal Sealant, or equivalent
 2. Expandable sealing bags, Tyco T-DUX
 3. Expanding foam, 3M Part #4416 Duct Sealant Kit, or equivalent product designed specifically for duct sealing (expanding foam for insulation (e.g. Great Stuff) is not acceptable)
- E. Innerduct conduits
1. Manufacturers
 - a. Carlon, Ribbed Wall High Density Polyethylene, 1 ¼" OD, orange
 - b. Carlon, Corrugated High Density Polyethylene, 1 ¼" OD, orange
 - c. Endot, EDOCOR corrugated, 1 ¼" OD, orange
- F. Pull tape
1. 3/8" or larger
 2. Manufacturers
 - a. Neptco
 - 1) Polyester Muletape, 2500 lbs minimum
 - 2) Detectable Muletape, 22 AWG, 2500 lbs minimum
 - b. Other acceptable manufacturers offering equivalent products
- G. Warning tape
1. High stretch polymer, orange tape, blank print
 2. Marked "Optic Fiber" or "Communications"
 3. Manufacturers
 - a. Empire Level Mfg., 25-071, Orange FO Cable MegaStretch
 - b. Other acceptable manufacturers offering equivalent products
- H. Tracer Wire
1. Green, insulated wire
 2. #10 copper conductor

- I. Concrete
 - 1. 3/8" maximum size
 - 2. Nominal compressive strength: 3000 PSI at 28 days
- J. Steel reinforcing bars
 - 1. Size- standard size #5
- K. Sand for filler
 - 1. Clean and graded
 - 2. All passing a #4 U.S. sieve
 - 3. Conforming to ASTM C33-01a (Standard Specification for Concrete Aggregates) for fine aggregates.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Digging and Trenching
 - 1. In general, underground pathways shall be at a minimal depth of 30" to the top of the pathway elements, where possible. Deviations from this specification must be pre-approved by the Owner's Personnel. Pathways may gradually slope up to under 30" deep to enter handboxes or handholes.
 - 2. Digging and trenching shall be in accordance with codes and requirements established by all applicable local, state, and federal agencies and departments.
 - 3. All trenching and digging shall be done in a neat and workmanlike manner. All methods of construction and details of workmanship shall be subject to the control and approval of the Owner.
 - 4. Contractors shall protect from direct damage during construction and damage resulting from construction all surrounding environments, including, but not limited to, existing roadways, sidewalks, curbing, trees and shrubs, open grass areas, and planting beds. Contractors shall use planking and ramps as needed to protect these areas.
 - 5. Contractors shall provide and install all necessary barriers to prevent unauthorized entry into the construction area. Contractors shall provide temporary walkways to divert pedestrian traffic safely around the construction area. Contractors shall contact the Owner's Personnel for approval of all temporary walkway locations.
 - 6. Contractors shall provide traffic control, signage, plating, etc. as necessary to maintain the safe flow of vehicular traffic as deemed necessary by the Owner's Personnel. Contractors shall contact the Owner's Personnel for approval of any changes to normal flow of vehicular traffic in and around the construction area and to arrange road closures, if necessary.
 - 7. Contractors shall restore, repair, rebuild, or replace any items including, but not limited to, adjacent property, existing fences, trees and shrubs, roadways and curbs, sidewalks, and surface utilities and parts damaged during construction. Damaged items shall restore,

- repair, rebuild, or replace to their original condition and to the satisfaction of the Owner's Personnel. The Owner's Personnel may waive this requirement for specific items if within the construction area and/or if scheduled for eventual demolition or replacement and at the Owner's Personnel discretion.
8. Contractors shall secure all necessary permits, as required. Contractors shall contact the Owner's Personnel to ascertain the existence of established permits covering this work.
 9. Contractors shall coordinate construction schedules and all work on the construction site with the Owner's Personnel. Other Contractors may be working in the area. Contractors shall coordinate construction schedules with any general contractor or construction manager hired by the Owner's Personnel when working as a subcontractor or when required by the Owner's Personnel.
 10. Contractors shall provide a detailed photographic survey of all pathways and areas to be disturbed prior to construction. Contractors shall deliver a set of these photographs to the Owner's Personnel prior to construction.
 11. Contractors shall locate and stake all pathways and spaces to be installed. Contractors shall confirm with the Owner's Personnel and the project engineers all staked pathways and spaces. Contractors shall notify the Owner's Personnel of any discrepancies in the site plan and the existing conditions.
 12. Contractors shall protect, support, and maintain all existing utilities in the work area as they are encountered during excavation. Shallow utilities to light posts or other devices may be temporarily re-routed or disconnected if pre-approved by the Owner's Personnel.
 13. Contractors shall install erosion control measures as needed to minimize erosion and to prevent soil run-off from the construction area.
 14. Contractors shall provide and install bracing, shoring, and sheathing as necessary to protect personnel and surrounding conditions. Contractors shall adhere to all local, state, and federal requirements for safe excavations.
 15. Contractors shall hand remove and stack all paving bricks and marble pavers in the construction pathway for re-installation later. Contractors shall remove granite or other stone ore brick curbing pavers in the construction pathway for re-installation later.
 16. Contractors shall saw cut all paved area encountered during excavations. Cuts shall be neat and straight.
 17. Contractors shall remove all material excavated including soil, rubble, debris, or other materials encountered during excavation. Contractors may store excavated material on site at the discretion of the Owner's Personnel and at the location designated by the Owner's Personnel. Contractors shall not anticipate storing excavated material on site. Excavated material from ductbank trenches may be left near the trench to be used as backfill, if adhering to later backfilling specifications. Contractors shall properly dispose of any material taken from the construction area per local disposal requirements.
 18. Contractors shall remove only the material necessary to safely install ductbanks as specified. Contractors shall contact the Owner's Personnel immediately if the trench or hole bottom is wet, unstable, or otherwise unable to support the infrastructure to be installed.
 19. Contractors shall provide pumps, as necessary, to keep water out of the excavation. Contractors shall direct effluent towards the nearest storm drain only if the effluent is free

from dirt and debris. Otherwise, the effluent shall be diverted to an area free from vehicular and pedestrian traffic and other construction areas.

20. Contractors shall notify the Owner's Personnel of any rock that cannot be excavated by a $\frac{3}{4}$ cubic yard power shovel or broken sufficiently by an air hammer to clear the space required for infrastructure installation. the Owner's Personnel shall determine the appropriate course of action.

B. Restoration

1. Contractors shall contact the Owner's Personnel prior to any backfilling which will conceal an installed pathway element to enable the Owner's Personnel to document and photograph the pathway.
2. Contractors may backfill in stages, when necessary to complete trenching and ductbank installation.
3. Contractors shall use pre-excavation photographs to restore the existing conditions, including brick walkway placement and pattern. Contractors shall restore brick walkways in the same pattern and arrangement as originally installed.
4. Contractors shall provide and install a level layer of compacted aggregate over each encased ductbank. The bed shall extend 1 foot above the surface of the ductbank. The first 6 inches of the aggregate bed shall be compacted to not less than 95% density compared to maximum laboratory tests by weight per ASTM D1557-64T, method A. The second six inches of the aggregate bed shall be compacted to not less than 85% density compared to maximum laboratory tests by weight per ASTM D1557-64T, method A.
5. Contractors shall remove all remaining excavated material from the construction area.
6. Contractors shall remove any erosion control devices no longer needed, not including those in and around seeded areas.
7. Restoration of disturbed landscaping shall be to the satisfaction of the Owner's Personnel.

C. Conduit/Duct Pathways

1. During construction, Contractors shall use appropriate personal protective equipment to work safely within trenches and excavated areas. Contractor shall provide all appropriate safety equipment as needed to extract disabled workers or as otherwise needed to provide a safe work environment and to provide immediate support in emergency situations.
2. Contractors shall store all conduits and fittings in a manner to prevent dirt, rain, and other debris from entering the conduits. All conduits and fittings shall be free from dirt, water, and debris before installation.
3. Contractors shall locate each ductbank as specified by this document and subsequent documentation provided by the Owner's Personnel.
4. Contractors shall install an aggregate bed of a minimum of 12 inches of compacted aggregate under the same specifications as maintenance hold installation (Section 7.3.2) for the first 6 feet of any ductbank exiting a maintenance hole.
5. Contractors shall mechanically tamp the bottom of all trenches to provide a firm surface. If a solid base is not achievable given soil or other conditions, the Contractors shall install

- a minimum 4" bed of compacted aggregate under the same specifications as maintenance hole installation (Section 7.3.2). Contractors shall excavate as needed to install this aggregate bed while maintaining 30" of minimal cover over the final ductbank. the Owner's Personnel shall determine the need for an aggregate base prior to the placement of any framing and laying of conduit in place.
6. Contractors shall obtain the Owner's Personnel permission to proceed prior to the laying of conduits into the trench.
 7. When possible, the vertical trench walls shall be used as the vertical frame for pouring concrete. When necessary, the sides of trenches shall be framed to maintain a straight and neat cross-section for areas completely encased by concrete. Contractors shall not use framing in areas to be filled with sand.
 8. Contractors shall use exterior maintenance hole walls, utility tunnel walls or roof, and/or building structure as framing into which the concrete is to be poured where possible.
 9. When penetrating a MH or building, Contractors shall core-drill, shall use a pre-manufactured knock-out window, or shall sawcut a window to penetrate the structure. Contractors shall confirm with the MH manufacturer or a structural engineer that the proposed method to access a structure and the final configuration of conduits per J the Owner's Personnel shall not compromise the structural integrity of the structure. Contractors shall provide the Owner's Personnel with written documentation to this effect.
 10. Contractors shall provide and install framing as necessary to prevent the penetration of concrete into the interior space of a structure. Contractors shall remove this framing when the concrete has properly set and after backfilling is complete.
 11. Contractors shall install horizontal conduits ending in structures flush with the interior surface of the wall. Contractors shall install vertical conduits ending in entrance facilities such that they extend a minimum of 4" above the final floor. Contractors shall cut the conduits square with the conduit and not necessarily level to the floor. Contractors shall provide and install bushings on conduit ends.
 12. Contractors shall provide and install conduit spacers beneath each conduit three times for every 20 linear feet of conduit. The spacers shall be evenly distributed over each 20 segment (e.g. one at each 20 foot joint and two evenly spaced over the middle). Each horizontal row of spacers shall be installed with a 6" minimum horizontal distance from any other row of spacers so as to eliminate weak vertical shear planes.
 13. Contractors shall provide and install steel reinforcing bars, vertically and horizontally, to form a vertical box framing the conduits. The vertical bars shall be driven a minimum of 6 inches deep to prevent the conduits from floating during concrete pouring. The horizontal bars shall be secured to the vertical bars to prevent movement. The vertical bars shall extend 3 inches above the top conduit row. Alternately, the bars may be less than 3 inches above the top conduit row, if an inverted spacer is placed on the top row to provide a 3 inches depth gauge for pouring concrete.
 14. Contractors may use "U"-shaped bars to straddle the conduits, if driven into the trench as specified above. Contractors may use a single horizontal bar or an upward pointing "U"-shaped bar in this configuration. The upward pointing "U"-shaped bar shall extend 3 inches over the top conduit or the Contractors shall use an inverted spacer to provide a 3 inch depth gauge for pouring concrete.
 15. Contractors shall provide and install reinforcing bars, longitudinally, as detailed in the drawings. The bars shall be secured to each vertical reinforcing bar box. The longitudinal

bars shall overlap 12 inches, unless welded together, and shall be secured to each other in a way to prevent movement.

16. When abutting a MH or building. Contractors shall provide dowel holes in each structure to enable the longitudinal reinforcing rods to penetrate the structure far enough as to prevent vertical and horizontal shearing of the ductbanks from the structure. Contractors shall not penetrate the wall with these holes. Contractors may need to provide and install additional reinforcing rods to provide this type of anchoring around MH window knock-outs.

D. Concrete Encasement

1. When encasing a ductbank, Contractors shall provide and install concrete around the conduits providing at least 3 inches of concrete around all sides of the conduit ductbank for the areas indicated on the drawing for complete encasement.
2. Contractors shall use appropriate methods to remove air pockets from the concrete and to provide 100% fill around all conduits and spacers.
3. Contractors shall fully encase any ductbanks that penetrate a MH or building for the first 6 feet beyond the structure.
4. When transitioning from an encased ductbank to a capped ductbank, Contractors do not have to frame the transition in cross-section, provided the required area is encased to a minimum of 3 inches. The concrete may slope down into the area to be capped. If the Contractors frame a transition point, the frame must be removed prior to installing aggregate around the conduits and installing the cap.
5. Contractors shall shape the top of the concrete in such a way as to slope water away from the ductbank-structure seams.

E. Cap Preparation and Installation

1. When capping a ductbank, Contractors shall provide and install filler sand around the conduits providing at least 3 inches of sand below and to the side of all conduits. Contractors shall not install filler sand above the top of the conduit ductbank.
2. Contractors shall use appropriate methods to remove air pockets from the sand and to provide 100% fill around all conduits and spacers.
3. Contractors may provide and install framing on the compacted surface of the sand for pouring the concrete cap.
4. Contractors shall provide and install a 3 inch thick concrete cap over the conduits for the areas indicated on the drawing. Contractors shall use appropriate methods to remove air pockets from the concrete.
5. Contractors shall extend the cap horizontally to a minimum of 3" beyond the outer most conduits.
6. If the cap is framed, Contractors may use lesser-grade backfill material to cover the sand beyond the cap once the framing is removed.

F. Final Installation of New Pathway

1. Contractors shall clean all conduits by pulling cylindrical brushes until all dirt is removed. Contractors shall blow all conduits dry.

2. Contractors shall install Muletape pull strings into all conduits.
3. Contractors shall install a tracer wire in one of the conduits of a new pathway. In maintenance holes, handboxes, and entrance facilities, the tracer wire shall be bonded to ground. The wire shall be clearly labeled.
4. In maintenance holes, the tracer wire shall loop up to the neck such that it can be reached without entering the hole. The wire shall be securely anchored along the neck, ceiling and wall.
5. Contractors shall install duct plugs at both ends of all conduits.

G. Existing Ductbanks

1. Contractors may use conduits and/or innerducts within existing ductbanks as directed by the Owner's Personnel. Where possible, used conduits with available innerducts or space shall be used.
2. When installing optical fiber into a 4" conduit without existing innerduct or cable, Contractors shall install three 1 - ¼" OD innerducts or three MaxCell 3-cell products.
3. When installing a 200 pr. copper cable, or less, Contractors shall install two 1 - ¼" OD innerducts with the cable. When installing larger copper cables, Contractors shall install one 1 - ¼" OD innerduct, if possible.
4. Contractors shall use ribbed innerduct. Contractors may use corrugated innerduct only when necessary to make tight bends and then only as much as needed before making a transition to ribbed innerduct.
5. Contractors shall install Muletape pull strings in all innerducts.
6. Contractors shall install pre-formed duct plugs around innerducts and smaller compression-type duct plugs in the innerducts.
7. Contractors shall seal used conduits (when pre-formed plugs are not feasible) with a non-hardening, removable sealant (PT Tech DuckSeal Sealant) or with an expandable sealing bag (Tyco T-DUX). Expanding foam products designed specifically for duct sealing (e.g. 3M Part #4416 Duct Sealant Kit) may only be used on conduits considered to be at capacity by the Owner's Personnel.
8. Innerducts shall not extend beyond six inches from the end of the conduit.
9. Contractors shall replace any Muletape pull strings installed in conduits subsequently removed during installation, including outside of newly installed innerducts. Muletape pull strings in innerducts used to pull a cable does not need to be replaced.

H. Tunnel Pathways

1. Tunnel pathways are considered spaces under this specification. Refer to the latter section for specifications.

I. Direct-buried Pathways

1. Direct-buried pathways shall not be used for permanent installations.

END OF SECTION 270543

SECTION 270553 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Documentation practices and requirements of cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, Telecommunications Rooms, and other telecommunications spaces.

1.2 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. This Section specifies the requirements for the Identification for Communications Systems.
- B. Work covered by this Section shall consist of furnishing labor, equipment and materials necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

1.4 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the latest applicable requirements of:
 - 1. ANSI/TIA/EIA - 606-A Administration Standards.
 - 2. ANSI/TIA/EIA - 569 Pathway and Spaces
 - 3. ANSI/TIA/EIA - 568-B Telecommunications Cabling Standard.
 - 4. BICSI Telecommunications Distribution Methods Manual.
 - 5. UL 969.

1.5 TELECOMMUNICATIONS ADMINISTRATION

- A. Administration of the telecommunications infrastructure includes documentation of cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, Telecommunications Rooms, and other telecommunications spaces.
- B. Coordinate with the Owner's Personnel for Labeling Standards and Conventions.
- D. Telecommunications Infrastructure Records must be maintained in a computer spreadsheet, or in a computer database. Paper records are encouraged, but are optional. A cable record is prepared for each backbone cable. The record will show the cable name, and must describe the origin point and destination point of the cable. The cable record will record what services and/or connections are assigned to each cable pair or strand. An equipment record is prepared for services distributed from a certain piece of equipment, such as a router, or a

system such as the telephone system PBX.

- E. Installer shall maintain accurate, up-to-date Installation or Construction Drawings. At a minimum, the Installation Drawings shall show pathway locations and routing, configuration of telecommunications spaces including backboard and equipment rack configurations, and wiring details including identifier assignments.
- F. Installer shall provide a complete and accurate set of as-built drawings. The as-built drawings shall record the identifiers for major infrastructure components including; the pathways, spaces, and wiring portions of the infrastructure which may each may have separate drawings if warranted by the complexity of the installation, or the scale of the drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Panduit
- B. Brady Corporation
- C. Deal
- D. Brother P-Touch

2.2 LABELS

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
- C. Where insert type labels are used provide clear plastic cover over label.
- D. Outside plant labels shall be totally waterproof even when submerged.
- E. Equipment Room Copper, Fiber, and Coax Backbone Cable Labels
 - 1. Panduit Part#LS7-75NL-1 or Brady#WML-1231-292
- F. Equipment Room Copper, Fiber, and Coax Horizontal Cable Labels
 - 1. Panduit Part#LS7-75NL-1 or Brady#WML-317-292
- G. Work Area Copper, Fiber, and Coax Riser Cable Labels
 - 1. Panduit Part#LS7-75NL-1 or Brady #WML-317-292
- H. Patch Panel Labels
 - 1. Panduit Part #LS7-38-1 or Brady #CL-111-619

PART 3 EXECUTION

3.1 IDENTIFICATION & LABELING

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

- A. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
- B. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
- C. All labels shall be printed or generated by a mechanical device.

3.2 TELECOMMUNICATION IDENTIFIERS

- A. Outside Plant cabling shall be clearly marked using permanent means. Outside plant shall use the following system of numbering and labeling:
 - 1. Fiber Optic:
 - a. Identify: far-end building name, building number, fiber-type and strand-count
 - b. Label at entrance and exit points of tunnel system and at conduit entry points between 12 inches and 36 inches from the conduit or at closet point that is clearly visible, and long cable length in tunnel at 200 foot intervals.
 - c. Label at termination panels at both ends.
 - 2. Copper:
 - a. Identify: far-end building name, building number and strand-count
 - b. Label at entrance and exit points of tunnel system and at conduit entry points between 12 inches and 36 inches from the conduit or at closet point that is clearly visible, and long cable length in tunnel at 200 foot intervals.
- B. Riser cabling shall be clearly marked using permanent means. Riser cabling shall use the following system of numbering and labeling:
 - 1. Fiber Optic:
 - a. Identify: far-end EF / ER / TR, fiber-type and strand-count .
 - b. When small facilities are fed from a primary location and treated as an ER, riser shall be labeled similar to Outside Plant Fiber Optic.
 - 2. Copper:
 - a. Identify: far-end EF / ER / TR and pair-count
 - b. Termination points shall be labeled as to actual pair at every fifth (5th) pair-point.

3.3 LABELING PROCEDURES

- A. To be consistent with ANSI/TIA/EIA standards and industry practices, it is important that both labeling and color coding be applied to all telecommunications infrastructure components. Labeling with the unique identifier will identify a particular component. Proper color coding will

quickly identify how that component is used in the overall telecommunications infrastructure of the facility.

B. Visibility and durability

1. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
2. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
3. Labels are generally of either the adhesive or insert type. All labels must be legible, resistant to defacement, and maintain adhesion to the application surface.
4. Outside plant labels shall be totally waterproof, even when submerged.
5. Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.
6. Other types of labels, such as tie-on labels, may be used. However, the label must be appropriate for the environment in which it is used, and must be used in the manner intended by the manufacturer.

C. Mechanical generation

1. All labels shall be printed or generated by a mechanical device.

END OF SECTION 270553

SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Equipment room fittings for ER/MDF and TR/IDF facilities.

1.2 RELATED SECTIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 27 05 00 – Communications Common Work Results

1.3 SUMMARY

A. Communications Equipment Room Fittings

1. The communications service entrance pathway will consist of a minimum of four (4) 4" conduits from the Building Entrance Point to the ER/MDF.
2. Space for new outside plant copper and fiber optic cable and terminating hardware mounted in contractor provided 19" racks will be provided in the ER/MDF.
3. ER and TR facilities shall include the following:
 - a. ER/MDF Room: Shall not be less than the following size depending on the total building area being served. Note: Special purpose rooms, such as laboratories, computer rooms and certain instructional spaces, may have higher than average density of communications outlets. The size of the ER/TR serving these rooms shall increase accordingly, as determined by ITNO.
 - 1) <10,000 sq. ft.: 8' X 10'
 - 2) <20,000 sq. ft.: 10' X 15'
 - 3) <30,000 sq. ft.: 15' X 15'
 - 4) <40,000 sq. ft.: 17' X 17'
 - 5) <50,000 sq. ft.: 19' X 19'
 - b. TR/IDF Room: Shall not be less than the following size depending on the total building area being served.
 - 1) <5,000 sq. ft.: 4.5' X 4.5'
 - 2) >5,000 < 8000 sq. ft.: 10' X 7'
 - 3) <8,000 sq. ft.: 10' X 9'
 - 4) <10,000 sq. ft.: 10' X 11'

- c. 24/7 environmental controls - 18 °C to 24 °C (64 °F to 75 °F). The humidity range should be 30% to 55% relative humidity.
- d. Ceiling height a minimum of 7 ft 6 inches (7' 6") above finished floor (AFF)
- e. No false ceilings or water pipe within the room's interior or running horizontally on the floor above.
- f. Light fixture height a minimum of 8.5 ft AFF, with a minimum equivalent of 500 lux (50 foot candles) measured 3' AFF, with 30% emergency light fixtures, if available. Fluorescent lighting is prohibited.
- g. Dedicated Telecom Room power panels fed from UPS distribution, if available.
- h. Convenience electrical outlets shall be installed on a side wall to allow for power cables to be run along relay racks, minimizing possibility of tripping hazards.
- i. A minimum of one (1) duplex convenience outlet shall be placed at 6 foot intervals around perimeter walls immediately to the left and right of the door for general purpose use. Duplex utility outlets shall be placed at a 18 inches AFF.
- j. At a minimum, one 240 volt 30 AMP dedicated circuit with a NEMA L6-30R receptacle and one 240 volt 20 AMP dedicated circuit with a NEMA L6-20R receptacle shall be installed at a height of seven (7) feet AFF. Both conduit and outlets shall be connected to the outside of the basket tray facing rear of the relay racks.
- k. At a minimum, there shall be four (4) 120 volt 20 AMP dedicated outlets with each pair on a dedicated circuit with emergency generator back-up. These outlets are to be located at a height of seven (7) feet AFF and both conduit and outlets shall be connected to the outside of the basket tray facing the rear of the equipment racks. Final design and layout approval on the number, type and location of the outlets shall be provided by ITNO.
- l. At a minimum, there shall be one (1) 20-amp 120-volt single phase circuit per rack. All telecommunication circuits shall be clearly labeled on circuit breaker panels with the circuit identification number located on the faceplate of the outlet in the telecommunications room.
- m. $\frac{3}{4}$ "void-free" AC-grade marine plywood on all walls, 8 ft high, painted with at least two coats of light colored fire retardant paint. Fire Marshall to inspect and approve before painting. Paint should be equivalent to: Flame Control Coatings, LLC. Flame Control NO. 20-20A. Fire Hazard Classification, ASTM E-84 (NFPA 255) Class "A". Treat with:
 - 1) DRICON (Arch Wood Protection, Inc.)
 - 2) D-blaze (Chemical Specialties, Inc.)
 - 3) FirePRO (Osiose, Inc.)
- n. A Telecommunications Main Grounding Bus Bar (TMGB) in the MER and Telecommunications Grounding Bus Bar (TGB) in the TR and a Bonding Conductor for Telecommunications (BCT) that bonds the TMGB to the electrical power ground compliant with ANSI J STD-607 A Standards

- o. Equipment racks and overhead runway (ladder rack) system as shown in T-drawings.
- p. 4" riser sleeves between stacked ER/TRs as shown in T-drawings.
- q. Building Entrance stub-ups as shown in T-drawings.
- r. Cage covered fire suppression elements
- s. A floor rating greater than 50 lbf/ft² distributed loading
- t. Fully-opening, secured, lockable, solid-core doors that are at least 3 ft wide and 6.7 ft 80 in) tall and open outwards from the room.
- u. Door locking mechanisms shall be cored with a campus-standard system to accept the Telecommunication Room standard keying.
- v. Rooms shall not provide for pass-through or over-head conduits serving plumbing, HVAC or electrical services, except for sprinkler systems.
- w. No panels for electrical or other services shall be contained in a TR/ER.
- x. Rooms shall be located to maintain compliance with TIA/EIA distance limitations and stacked vertically whenever possible.
- y. Conduits entering room shall be located within 4" of wall and conduit outer diameter and stubbed 2" into room.
- z. An additional two conduits, sleeved cores or cable tray, over and above the current requirements shall be included for future growth.
- aa. Appropriately sized UPS shall be installed in every Telecommunication Room and in Equipment Rooms having rack-mounted equipment/hardware.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Equipment Racks – Heavy duty aluminum 6' floor mounted racks with cable management channels on both sides and mounting rails for 19" equipment are required.
 - 1. Ortronics.
 - a. Mighty-Mo - 6', 19" rails, 16.25" deep channel
 - b. Grounding Bar
- B. Vertical Cable Management
 - 1. Ortronics.
 - a. MM6 Vertical cable management "cage" with door, 10", 13", 6'
 - b. MM6 Vertical cable management "cage" with door, 6", 8", 6'

- 2. Chatsworth
 - a. Short Rack - Universal Rack
 - b. Height below 7' (3' to 6')
 - c. 19" rails
 - d. Black
 - C. Horizontal Cable Management
 - 1. Ortronics
 - a. Cable Management Panel with cover, 2U (OR-MM6HMF2RU)
 - b. 2U - NCMHF2
 - D. Basket Cable Tray
 - 1. Cablofil
 - a. 12" x 2" – CF54 /300 EZ
 - b. 12" X 4" – CF105 / 300 EZ
- 2.2 RELAY RACKS
- A. Equipment racks shall be capable of accepting 19" equipment, self-supporting and manufactured from high-strength aluminum with two top brackets included for additional strength.
 - B. Finish color shall be black. Mounting holes shall be drilled and tapped each side at 5/8"-5/8"-1/2" patterns compatible with EIA 1-1/4"-5/8" alternating patterns.
 - C. The rack shall include base flanges with mounting holes drilled through for securing the rack to the floor. Each mounting hole must be at least 5/8" in diameter.
 - D. Where the rack is to be mounted to VCT flooring or bare concrete, an insulating pad must be used, and care must be taken that anchors, used to secure the rack to the floor, do not come in contact with any reinforcing steel embedded in the concrete slab.
 - E. In the Telecommunications and Equipment Rooms a minimum of six (6) rack mount spaces are reserved at the top of each rack for fiber enclosures.
- 2.3 CABLE MANAGEMENT
- A. Vertical cable management shall be double-sided and narrow or wide depending upon application requirements. Each manager section shall have a black finish. Lockable latching sections and protective edge guards shall be included.
 - B. Horizontal cable management shall be capable of attachment to a 19" rack, maximum 6" deep and maximum 2.8" high. Each manager shall have a black finish.

2.4 CABLE RUNWAY

- A. Subject to compliance with these specifications, cable runway shall be as manufactured by Chatsworth Products, Inc. Cable runway (ladder rack) is required within the ER/TR's to provide a suitable pathway to route all cabling into and out of termination equipment, mounted in equipment racks or on backboards attached to walls, and pathway spaces beyond the ER/TR.
- B. Runway: Provide UL classified cable runway and components. Such products are to be UL classified as to its suitability as an equipment-grounding conductor. Cable runway and components are to have rounded edges and smooth surfaces in compliance with applicable standards, and with the following additional construction features:
 - 1. Dimension: The cross sectional area of the side rail shall be greater than 0.20 square inches. The height of the side rail must remain at 1-1/2 inches.
 - 2. Material and Finish: All cable runway and components shall be made of tubular steel and finished with flat black powder coat paint or gold chem film over zinc plating.
 - 3. Construction: Cable runway is a prefabricated metal structure consisting of two longitudinal side rails connected by individual transverse members. Cable runway shall be constructed of 1-1/2" x 3/8" x .065" rectangular steel tubing. Cross members shall be a single continuous rectangular tube 1/2" x 1" x .065" with radiused corners. Cross members shall be welded to stringers at 9" intervals with ends finished to protect installers and cables.
 - 4. Cable runway width shall be 12 inches except as otherwise shown on the Telecommunications Drawings.
 - 5. Cross members shall be spaced every 9 inches at a minimum.
- C. UL Classified Runway Butt-Splice Kit: Consists of 4 splice plates, U-shaped. Overall, 5" by 5/8" by 11/16" thick. Provided with 7/16" by 3/8" cutout for insertion of trimmed head bolt. Bolt measures 3/8" diameter by 2-1/2" long provided with hex nut and lock washer.
- D. UL Classified Runway Junction Splice Kit: L-shaped splice angles. Overall, 2" x 2" by 1-1/2", 3/16" thick. Secured to cable runway by 3/8" diameter by 1-1/2" hex bolts, nuts and lock washers.
- E. UL Classified 90 Degree Runway Splice Kit: Outside Clamp - Overall, 5-3/4" x 3/4" by 5/8", minimum 0.10 thick. Provided with 7/16" by 7/16" cutout for insertion of trimmed head bolt. Bolt measures 3/8" diameter by 3-1/4" long. Provided with hex nut and lock washer. Inside Edge Clamp - Overall, 2-9/16" x 15/16" x 5/8", minimum 0.10 thick. Provided with 7/16" x 7/16" cutout for insertion of trimmed head bolt.
- F. UL Classified 45 Degree Runway Splice Kit: Outside Clamp - Overall, 4-7/16" x 5/8" x 3/4", minimum 0.10" thick. Provided with 7/16" x 7/16" cutout for insertion of trimmed head bolt. Bolt measures 3/8" diameter by 2-11/16" long provided with hex nut and lock washer. Inside Edge Clamp - Overall, 2-9/16" x 15/16" x 5/8" minimum 0.10" thick. Provided with 7/16" x 7/16" cutout for insertion of trimmed head bolts.

PART 3 EXECUTION

3.1 GENERAL

A. ER / TR

1. Cabling within Racks and Enclosures: provide adequate length of cabling. Train conductors to termination terminal points that follow manufactures installation procedures for maintaining cable performance specifications. Provide lacing/mounting bars to restrain cables, to prevent straining connections, and to stop bending cables to smaller radii than minimums recommended by manufacturer.
2. Equipment Racks: Provide 19" wide x 7'-0" tall racks with number of vertical rack sections as required to allow space for termination of all fiber and data/voice cabling plus mounting space for multi-port concentrators (Hub/Switches) required to cross-connect all data jacks.
3. Locate/space racks and enclosures according to EIA/TIA guidelines for front and around access.
4. Vertical wire management: double-sided vertical rack cabling sections. Reference E. Drawings
5. Entrance: Arrange and coordinate locations of distribution frames, patch panels, cross-connections in communication rooms and racks to optimize space requirements of any service provider requirements, telephone system and LAN equipment.
6. Provide cable runway in equipment room above all racks and up to runway/conduits/sleeve's entering room from corridors to form a complete runway system connecting all hardware installations. Attach grounding lugs to each rack/cable raceway, conduit, etc. Refer to 'E' drawings for details.
7. Install trays overhead along the equipment rows, leading to the cross-connects. Coordinate tray locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation. In the United States, NEC Article 392 provides requirements for cable trays.
8. Provide horizontal cable runways. Equip each 19" rack with overhead ladder style cable runway installed between the wall and horizontal/equipment racks. Refer to drawings for proposed locations and sizing of each runway. Securely attach to wall studs with support brackets (and racks if applicable), in accordance with manufacturer written instructions.
9. Provide ground lug for each 19" rack. Racks shall be grounded to wall mounted ground bus bar using #6 AWG stranded, green jacketed, insulated copper conductor. Furnish all required bonding material and hardware, and bond to building grounding electrode subsystem TMGB in ER. If crimp connectors are used to bond the #6 AWG wire, follow NEC bonding procedures/specifications.
10. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.

END OF SECTION 271100

271113 – COMMUNICATIONS ENTRANCE PROTECTION

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 27 05 26: Grounding and Bonding for Communications Systems.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2002.
- B. See Section 27 00 00: Communications General.

1.3 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.4 DESIGN REQUIREMENTS

- A. The design shall specify building entrance terminals (BET) and protector modules of the type and manufacturer specified by this document.
- B. Design for multiple BETs such that grounding conductors connecting them are straight. Design BETs such that grounding conductors connecting them to the TMGB are as straight as possible.
- C. Do not specify BETs to be inter-connected with horseshoe-shaped conductors. For multiple columns or rows of BETs, each column or row shall be connected to the EF busbar in as straight a fashion as possible.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Building Entrance Terminals
 - 1. 710 module or 110-style block on the “in” side
 - 2. 110-style block on the “out” side
 - 3. Fully enclosed housing covering terminations and modules
 - 4. Manufacturer
 - a. Circa
 - b. No substitutions
- B. Building Entrance Terminal Modules

1. PTC (positive temperature coefficient) version
2. Manufacturer
 - a. Circa, C4B1E (PTC)
 - b. No substitutions
- C. Other materials as needed to connect to the telecommunications grounding system.

PART 3 EXECUTION

3. 1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Contractors shall install multiple BETs such that grounding conductors connecting them are straight. Contractors shall install BETs such that grounding conductors connecting them to the TMGB are as straight as possible.
- C. Contractors shall not inter-connect connect BETs with horseshoe-shaped conductors. For multiple columns or rows of BETs, each column or row shall be connected to the entrance facility bus bar in as straight a fashion as possible.
- D. The Contractor shall not connect more than BET to another BET beyond the TBB connection. Manufacturer requirements shall be followed and allow for a single BET to act as a "hub" for other BETs, but not beyond a second tier.

END OF SECTION 271113

271116 – COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURE

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 27 11 00 - Communications Equipment Room
- B. Section 27 11 19 - Communications Termination Blocks and Patch Panels
- C. Section 27 11 26 - Communications Rack Mount Power Protection and Power Strips

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2002.

1.3 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.4 DESIGN REQUIREMENTS

- A. Prepare rack layouts showing the placement of all equipment within each rack.
- B. Typical racks shall be 7 ft. high and have 19" rail spacing. Create network room layouts based on actual dimensions of approved products. The preferred equipment rack is the Ortronics Mighty-Mo 20 rack (16 inch depth). The preferred equipment cabinet is the Chatsworth TeraFrame. Racks to contain Cisco Catalyst core switches or other large equipment requiring forward and rear attachment points to an open rack should be mounting into Ortronics racks. This equipment can be mounted in Chatsworth cabinets.
- C. Security cabinets for video surveillance or access control systems shall be in a dedicated rack.
- D. Smaller installations may be designed to use wall-mount cabinets or enclosures, provided the initial installation does not exceed 50% of the vertical rail space.
- E. Equipment rooms needing higher security may be designed to use Chatsworth Cabinets.
- F. Equipment cabinets require one full louver door on front and back, with minimum one fan rack unit and two 5 inch grommet holes in each side and top protected with plastic or rubber edging.
- G. Ground equipment racks as specified under Section 27 05 26 Grounding and Bonding for Communications Systems.
- H. Specify all wire management rings, ladder rack, brackets and wire management panels which, in the sole judgment of Owner shall be required for a neat and workmanlike installation.
- I. Plastic or metal cable ties shall not be used in the network rooms. Velcro cable ties shall be used.

- J.
- K. Specify the use of vertical and horizontal wire management on rack configurations. When configuring multiple racks in a line, the vertical cable management between racks shall be the larger size, while the smaller channels may be used at the ends. If future racks are anticipated, do not down-size the end likely to receive another rack.
- L. Equipment cabinets require one full louver door on front and back, a minimum one fan rack unit and two 5 inch grommet holes in each side and top protected with plastic or rubber edging.
- M. Ground equipment racks as specified under Bonding and Grounding.

PART 2 PRODUCTS

2.1 RACKS AND ACCESSORIES

A. Racks and Rack Accessories

1. Ortronics

a. Might-Mo 20, 7' high, 19" rails, 16.25" deep channel

1) Horizontal cable management:

(a) Ortronics Cable Management Panel With Cover, 2U, (OR-MM6HMF2RU)

2) Vertical cable management:

(a) Preferred -Ortronics MM6 Vertical Cable Management "Cage", with door, 10" x 13" x 7', black (OR-MM20VMD710-B)

(b) Ortronics MM6 Vertical Cable Management "Cage", with door, 6" x 8" x 7', black (OR-MM20VMD706-B)

B. Short Racks and Rack Accessories

1. Chatsworth

a. Short Rack- Universal Rack

1) Height below 7 feet (3 feet to 6 feet-6)

2) 19" rails

3) black

2.2 CABINETS

A. Cabinets

1. Chatsworth Products

- a. TeraFrame Cabinet
- b. 36, 40 or 48" deep
- c. 19" rails
- d. Size as needed, not to exceed 50% initial capacity
- e. Black

B. Wall-mount Cabinets

1. Full-depth Cabinets

- a. Ortronics
 - 1) Mighty Mo Wall Mount Cable Management
 - 2) 12, 16, or 21 U rails
 - 3) Black
 - 4) Size as needed, not to exceed 50% initial
- b. Chatsworth Products
 - 1) M-Series 48" MegaFrame Cabinet
 - 2) 24", 30", or 36" deep
 - 3) 19" rails
 - 4) Size as needed, not to exceed 50% initial
 - 5) Black

2.3 ENCLOSURES

A. Shallow enclosures

1. Hubbell REBOX

- a. Model RE2 - 2U for switches, 2U for patch panel
- b. Model RE4 - 5U for switches, 4U for patch panels
- c. Fan kit (2 for RE4; 1 for RE2)
- d. Fitted with standard locking hasp to receive full size padlock

2. Chatsworth Wall-Mount Enclosure

- a. Part number: AAT-AWM-H

b. Size 42"W x 24"H x 7.5"D

c. Space for a single 100 pair 110 style termination block, a single 6-port fiber optic adapter panel, two 19" x 2U spaces for patch panels or other panel mount termination hardware and one 19" x 3U space for active components up to 18" in depth

2.4 ACCESSORIES

A. Specify the appropriate grommet per manufacturer and cable type and quantity requirements.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The Contractor shall install open racks as shown in drawings by securely fastening the rack to the deck.
- B. The Contractor shall provide horizontal cable management above and below the housing, as needed for a single management unit above and below the housing, dependent on final placement of the housing.
- C. The Contractor shall securely fasten side-by-side racks to each other using rack manufacturer hardware.
- D. The Contractor shall provide and install rack parts as shown on drawings provided.
- E. The Contractor shall bag and leave attached to the tray any unused mounting screws or other hardware upon completion.
- F. Provide vertical and horizontal cable management sized for no more than 40 percent fill.
- G. Mount with minimum of 36 inches clear access behind and in front of rack/cabinet.
- H. Ground rack/enclosure to TMGB / TGB with Grounding Wire.

END OF SECTION 271116

271119 – COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 GENERAL

1.1 REFERENCES

- A. NFPA 70 - National Electrical Code: National Fire Protection Association; 2002.

1.2 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.3 DESIGN REQUIREMENTS

A. Horizontal Copper Rack Terminations

1. All horizontal cables shall be terminated in the T568B pin/pair configuration. All four pairs shall be terminated.
2. Cables shall be neatly dressed to their respective patch panel and within rack cable management using Velcro cable ties and/or rack cable management loops. Cables shall not be bundled outside of a rack, but shall be loose and random in cable tray.

B. Fiber Rack Terminations

1. Terminate the fiber on a rack mounted patch panel. All fiber-optic connecting hardware shall support individually terminated fibers onto the connectors. Adapter panels shall be limited to a single type of fiber (multimode or single mode).
2. Optical fiber cable shall be terminated in an appropriately sized, rack mountable enclosure. These enclosures shall be lockable (if room access is not controlled). All optical patch panels shall meet all requirements set forth in the ANSI EIA/TIA-568-A wiring standard for connecting hardware. Termination panels shall be mounted in the top of the rack or cabinet.
3. The preferred fiber distribution housing is the Corning housing line.

C. Wall Mounted Terminations

1. Specify the installation of 110 blocks for wall field terminations. No wall-mounted hardware, including cable management, shall be above 5'6" from the finished floor.
2. Cable management troughs shall be installed such that all cross-connect wires may be installed within the troughs.
3. Provide a detailed wall field layout for installation.
4. Cable management may move as needed to accommodate conditions.
5. A clear space of 5" or 6" above and below the top and bottom of the connecting hardware shall be maintained for cable handling.

6. Service loops shall be secured to the wall as needed and in an unobtrusive manner. Service loops shall not block access to other cables, utilities, or otherwise accessed structures (e.g. shut-off valves, meters, etc.). Service loops shall not rest horizontally on cable trays.
7. Wall fields shall be designed to minimize the need to work behind equipment racks. Busbars and BETs can be readily located behind equipment racks while 100 block should be more accessible.
8. Wall field elements shall be 3 ft or more from any electrical service panels. Pathways within the space shall keep this clearance when possible.

PART 2 PRODUCTS

2.1 MATERIALS

A. Copper Terminations

1. Category 6 patch panels.
 - a. Belden/CDT
 - 1) GigaFlex PS6+ Patch Panels, 48 port (AX101613)
 - b. Ortronics
 - 1) Clarity6 Category 6 Patch Panels, 48 port, 8 port modules (OR-PHD68U48)
2. Category 6a patch panels.
 - a. Belden/CDT
 - 1) IBDN 10GX Patch Panels, 2 U, 48-port (AX103256)
 - b. Ortronics
 - 1) Clarity 10G Patch Panels, 2U, 48-port, 6 port modules (OR-PHD610U48)
3. Wall Terminations
 - a. Belden/CDT
 - 1) Category 5e 110 Wiring Block with legs (100-pair- AX100691-S; 300-pair- AX100692-S; kits with connection block have other part numbers)
 - 2) Connector Blocks (C4- AZ100707-S, C5- AX100708-S)
 - 3) Cable Management Trough with legs (AX100706-S)
 - b. Ortronics
 - 1) Ortronics Category 5e 110 Wiring Blocks with Legs (100 pair- OR-110ABC5E100; 300 pair- OR-110ABC5E300)

- 2) Ortronics Connector Blocks
- 3) 110 Jumper Trough with legs (OR-30200140)

B. Fiber Terminations

1. Intra-building Backbone Cabling

a. Corning Cable Systems

- 1) Rack Mount housing, Corning Edge Housing, sized appropriately for cable counts

EDGE™ Housing, 4 rack units, 576-fiber LC, 2304-fiber MTP® Capacity (48 modules/panels)	EDGE-04U
EDGE™ Housing, 2 rack units, 288-fiber LC, 1152-fiber MTP® Capacity (24 modules/panels)	EDGE-02U
EDGE™ Housing, 1 rack unit, 144-fiber LC, 576-fiber MTP® Capacity (12 modules/panels)	EDGE-01U-SP
EDGE™ Housing, 1 rack unit, 96-fiber LC, 384-fiber MTP® Capacity (8 modules/panels)	EDGE-01U

- 2) The following products are acceptable but only with a written approval from JHMCIS. JH IT department and will only be used in certain legacy applications: Rack-mount housing, Corning Pretium Housing, sized appropriately for the cable counts. Only 12 fiber LC connector panels are acceptable, nothing larger.

- 3) Wall-mount housing, Wall-Mountable Building Terminal (WBT), lockable (WBT-024-L)

b. Adapter Modules – All adapter modules are to match the fiber housings designated in section a.

- 1) Corning Cable Systems, Edge cassettes

EDGE™ Splice Cassette, 12 F, LC duplex, OM4, single-fiber	EDGE-CS12-AD-P00QE
EDGE™ Splice Cassette, 12 F, LC duplex, OM4, Ribbon, Straight Through	EDGE-CS12-AD-P00QJ
EDGE™ Splice Cassette, 12 F, LC duplex, Single-mode UPC, single-fiber	EDGE-CS12-AE-P00RE
EDGE™ Splice Cassette, 12 F, LC duplex, Single-mode UPC, Ribbon, Straight Through	EDGE-CS12-AE-P00RJ
EDGE™ Splice Cassette, 12 F, LC duplex, Single-mode APC, single-fiber	EDGE-CS12-AF-P00RE

EDGE™ Splice Cassette, 12 F, LC duplex, Single-mode APC, Ribbon, Straight Through	EDGE-CS12-AF-P00RJ
EDGE™ Adapter Panel, 12 F, Single-mode UPC, LC Duplex	EDGE-CP12-AE
EDGE™ Adapter Panel, 12 F, OM3/4 UPC, LC Duplex	EDGE-CP12-AD
EDGE™ Adapter Panel, 12 F, Single-mode APC, LC Duplex	EDGE-CP12-AF

- 2) The following adapters are only to be used when previously approved by JH IT staff and are to only be used in designated legacy projects.
- (a) Corning Cable Systems, 12 LC duplex adapters, single-mode, ceramic insert, composite housing (CCH-CP24-A9)
 - (b) Corning Cable System, 12 LC cassettes, 50 Micron multimode (CCH-CS12-A9-P00RE).
 - (c) Corning Cable System, 12 LC cassettes, Single Mode (CCH-CS12-E4-P00QE)
 - (d) Corning Cable System, 24 LC cassettes, 50 Micron multimode (CCH-CS24-A9-P00RE)
 - (e) Corning Cable System, 24 LC cassettes, Single Mode (CCH-CS24-E4-P00QE)
- C. All additional materials needed to properly terminate and secure cables, including but not limited to panel/plate connectors, grounding kits, strain-relief hardware, break-out kits, blank panels/plates, etc.

PART 3 EXECUTION

3.1 INSTALLATION

A. Horizontal Cable Rack Terminations

1. All horizontal cable shall be installed per manufacturer instructions to ensure a manufacturer certified solution.
2. The Contractor shall provide and install modular patch panels as shown on the attached drawings.
3. The Contractor shall terminate all horizontal cables in the T568B pin/pair configuration. All four pairs shall be terminated.
4. The Contractor shall neatly dress cables to their respective patch panel and within rack cable management using Velcro cable ties and/or rack cable management loops. Cables shall not be bundled outside of a rack, but shall be loose and random in cable tray.

5. Provide identification labels for each cable.

B. Optical Fiber Rack Termination

1. The Contractor shall provide and install rack-mounted optical fiber housing as shown on the attached drawings.
2. The Contractor shall terminate all fibers using dual LC connector panels/plates and fiber connectors.
3. The Contractor shall place all fiber slack neatly in the fiber housing.
4. The Contractor shall secure cable strength members to cable strain relief brackets or attachment points within the fiber housing.
5. The Contractor shall install panels/plates to fill all empty locations within fiber housings.
6. The Contractors shall install additional materials needed to properly terminate and secure the inter-building and intra-building optical fiber cables, including but not limited to panel/plate connectors, grounding kits, strain-relief hardware, break-out kits, blank panels/plates, etc.
7. Provide identification labels for each adaptor.

C. Wall Termination Fields

1. All wall field terminations shall be installed per manufacturer instructions to ensure a manufacturer certified solution.
2. The Contractor shall install 110 blocks and protectors as shown in the attached drawings. No wall-mounted hardware, including cable management, shall be above 5'6" from the finished floor.
3. Cable management troughs shall be installed such that all cross-connect wires may be installed within the troughs. Final installed locations may change during installation. Wire management shall be adjusted appropriately during installation.
4. The Contractor may move cable management as needed to accommodate conditions. Cable management will remain continuous from cross-connects between protectors and 110 blocks.

END OF SECTION 271119

SECTION 271300 – COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing in performing the following operations recognized as necessary for the installation, termination, and labeling of copper and fiber backbone infrastructure as described on the Drawings and/or required by these Specifications.
- B. Products
- C. Installation Requirements
- D. The building backbone riser system connects Telecommunication Rooms to each other, to the Main Service Entrance Room and to the Equipment Room. This project specifies separate cable systems to provide data, video and voice needs. The backbone riser system consists of plenum-rated, multi-pair twisted pair copper cables, coaxial, and single mode fiber cables along with associated termination systems.

1.3 RELATED SECTIONS

- A. 27 05 00 Common Work Results for Communications
- B. 27 05 53 Identification for Communication Systems

1.4 COORDINATION

- A. New cable plant requiring connection to, or disconnection from, the University campus networks shall be performed by personnel designated by Information Technology Network Operations. Campus networks include; telephone, local and wide area, video, cable television, and fiber optic networks.
- B. Contractor shall coordinate the work specified in this Section with the work in other parts of the Contract documents.
- C. Plans in general are diagrammatic. It is the full responsibility of the Contractor to be familiar with the location of equipment involved under the work of other trades to eliminate conflicts between the fiber and copper cable installation and the work of other trades.
- D. All questions and issues with regard to coordination shall be directed to the Owner.

1.4 SUBMITTALS

- A. Manufacturer's data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment.

- B. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Submit data electronically on CD-Rom disc in "Microsoft Excel 2007" format, listing products furnished, including:
 - 1. Manufacturer's name.
 - 2. Manufacturer's part numbers and com code numbers.
 - 3. Cable numbers utilizing the Owner's cable numbering standard.
 - 4. Location and riser assignments.
 - 5. This requirement applies to copper cable, fiber optic cable, and all termination equipment.
- C. Record Drawings: Furnish CAD drawings of completed work including cable numbers. Refer to item Section 27 05 53 for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.
- D. Cable Testing Reports.
 - 1. Submit Testing Plan prior to beginning cable testing.
 - 2. Submit certified test reports of Contractor-performed tests in accordance with this document.
 - 3. Electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable identification.
 - 4. Test reports shall be reviewed, approved and stamped by the Contractor's on-site RCDD.
- E. Product data for all termination and test equipment to be used by Contractor to perform work.
 - 1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
 - 2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
 - 3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
- F. Submit Cable Pulling Plan, as follows:
 - 1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
 - 2. Indicate contents of each conduit.
 - 3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
 - 4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.

5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.
- G. The Contractor shall submit installation plan indicating:
1. Equipment and personnel
 2. Materials and staging area
 3. Start and completion dates
 4. Locations, including floor, room and building
 5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
- H. The Contractor shall submit a copper cable pulling plan for all multi-pair copper cables with a pair count of 25 pairs or greater, that includes, but is not limited to, the following:
1. Each cable run and route.
 2. Date and duration of the pull.
 3. Pulling methodology and equipment setups.
 4. Pulling tension calculations for each pull in the run.
 5. Safety issues and precautions to be taken.
- I. Cable Splicing Submittals
1. Fiber fusion splicing method and procedures.
 2. Schedules of copper and fiber cables to be spliced.
 3. Copper splicing method and procedures.
 4. Certification documents for all splicing personnel.
 5. Cut sheets, showing accurately scaled components, of fiber and copper splice closures, accessories, clamps, brackets, hangers, splice connectors, splice joint assemblies and fittings.
- J. Shop Drawing Submittals to include:
1. Room penetration plan / drawing
 2. Communication extension pathway plan / drawing
 3. Riser conduit anchoring plan / drawing
 4. Conduit chase plan / drawing
 5. Communication pathway plan / drawing
 6. Junction box, gutter and pull box labeling plan / drawing
 7. Cabinet / rack elevation drawing

8. Floor plan drawing for all ER / TR rooms
9. Wall elevation drawings for all ER / TR rooms
- K. All submittals for substitutions or modifications shall be made to the JHU IT for approval prior to start of work.

1.5 QUALITY ASSURANCE

- A. Verification: The Owner shall maintain inspection personnel on the job site. It is incumbent upon the Contractor to verify that the installation and material used has been inspected before it is enclosed within building features, or otherwise hidden from view. The Contractor shall bear costs associated with uncovering or exposing installations or features that have not been inspected.
- B. Equipment: The Contractor is to use equipment and rigs designed for pulling, placement and termination of multi-pair copper cable; including reel trucks, mechanical mules, sheaves, shoes, anchors etc., and equipment for drilling masonry, installing anchors, etc., to install support and cable management hardware.

PART 2 PRODUCTS

2.1 COPPER CABLE

- A. Substitutions for products specified are not permitted without express written approval of Information Technology Network Operations.
- B. Solid Copper Backbone/Tie Copper Cable: 24 AWG, UTP, Category 3, OSP Backbone Cables with an overall metallic shield. Manufacturer: Berk-Tek - Part Number: 10032113
- C. Voice backbone cables installed in underground conduits or the tunnel shall be gel-filled PIC cable to a termination point within the ER. The backbone cable shall then be cross-connected to the protector blocks.
- D. All splice cases used in the multi pair voice backbone shall be waterproof.
- E. Building entrance protection for copper cabling shall be installed utilizing a two (2) foot fuse link between outside plant cable plant splice and the protector module with IDC-type input and output terminals, 100 pair-pair capacity and female mounting base, equipped with 230 volt solid state protector modules. Sufficient protector modules shall be provided to completely populate all building entrance terminals.
- F. The shield of all inter-building backbone cables must be bonded to the ground lug on the primary protector panel. The protector panel must be bonded to the Telecommunications Main Grounding Busbar. The shield of all intra-building backbone cables must be bonded to the Telecommunications Main Grounding Busbar.
- G. Voice backbone cables shall have a minimum 10-foot service loop when terminated in the ER and TR, and at any splice points in telecommunications manholes.

2.2 PROTECTOR PANELS

- A. Entrance Terminals - CIRCA 188OECA1-100G
- B. Protector Modules – CIRCA Gas Protector Unit – 3BIE

2.3 COPPER TERMINATION HARDWARE

- A. Main Cross Connect (MC)
 - 1. 5 Pair – Panduit P110KB1005
 - 2. 5 Pair – CommScope UNK-110-WB-5M-100PR
 - 3. 4 Pair – Panduit P110KB1004
 - 4. 4 Pair – CommScope UNK-110-WB-4M-100PR
- B. Entrance Facility (EF)
 - 1. 5 Pair – Panduit P110KB1005
 - 2. 5 Pair – CommScope UNK-110-WB-5M-100PR
 - 3. 4 Pair – Panduit P110KB1004
 - 4. 4 Pair – CommScope UNK-110-WB-4M-100PR
- C. 48 Port Angled Patch Panels, filled and terminated with appropriate number of black RJ-45 jacks.
 - 1. Panduit – UICMPPA48BL
 - 2. CommScope – M2000A-48

2.4 OUTSIDE PLANT FIBER OPTIC CABLE

- A. 48-strand 9/125 micron single-mode outside plant rated fiber optic cable: CommScope
- B. 12-strands 62.5/125 micron multi-mode outside plant rated fiber optic cable (MM OSP cable used only for fire alarm system): CommScope
- C. All fiber optic cable with loose tube construction installed underground shall be gel filled or be constructed of appropriate waterproofing compounds.
- D. A minimum of two (2) complete fiber optic loops in each manhole shall be installed in manholes between buildings.
- E. No splicing is allowed in fiber optic cables between buildings.
- F. Cable runs shall be installed in one continuous length from bulkhead connector to bulkhead connector without splices; including service loops, and repairs unless required by standard, otherwise written approval must be received from JHU IT Management.
- G. All newly installed fiber optic cable shall be placed inside fiber optic innerduct when not in conduit or utility tunnel cable tray. A pull string must be run in addition to the cable in order to provide access for future growth.
- H. Fiber optic cables shall always have minimum 20-foot service loop at the terminating ends and all approved splice points. Place service loops with large bend radii neatly bundled on walls or on the attached to the bottom side of ladder trays in 'figure-8' configuration.

2.5 INSIDE PLANT FIBER OPTIC CABLE

- A. 12-strands Plenum-rated 9/125 micron Singlemode fiber optic cable: Manufacturer - CommScope

- B. 6-strands Plenum-rated 62.5/125 micron Multimode fiber optic cable: CommScope

2.6 FIBER TERMINATION HARDWARE

- A. Rack-mounted Fiber Distribution Units for ER: CommScope #RFE-FXD-EMT-BK/4U
- B. Rack-mounted Fiber Distribution Units for TRs: CommScope #RFE-SLG-EMT/2U
- C. ST fiber connectors

2.7 FIBER PATCH CABLES

- A. Fiber Optic Patch Cords with ST connectors for both SM and MM Cable: Panduit
 - 1. Yellow for single-mode
 - 2. Orange for multi-mode
- B. One duplex patch cable for every fiber optic strand terminated.
- C. Patch cables to be of like type and connector to fiber cable.
- D. Length shall be adequate to reach owner provided electronic equipment mounted in lower section of relay rack.

PART 3 EXECUTION

3.1 CABLE INSTALLATION – OUTSIDE PLANT

- A. Fiber optic cable installed in manholes between buildings shall be a minimum of two (2) complete loops in each manhole.
- B. Splicing of fiber optic cable is not allowed between buildings.
- C. All fiber shall be installed in innerduct. Innerduct shall be spliced according to manufacturer approved methods.
- D. At a minimum, 48-strand, single-mode fiber of size 9/125 micron shall be installed. Final strand counts to be approved by ITNO. Single-mode fiber size shall be 9/125 micron. All Single-mode cables are not to exceed 1 dB plus .0008 dB per foot end to end attenuation at 1310nm.
- E. The average/maximum fiber splice loss for single-mode fusion splices shall be 0.05/0.3 dB and 0.10/0.3 dB for mechanical splices.
- F. Contractor shall submit the cable pulling plan to the Owner prior to commencement of the operation.
- G. The fiber shall be pulled in inner-duct inside the manhole to prevent damage to the cable. No splicing is allowed in fiber cables between buildings.
- H. All inner-duct shall be spliced according to manufacturer approved methods.
- I. The route of multi-pair copper cable installation is as described herein or as shown on the Drawings.
- J. The Contractor shall ensure the cables are pulled into the ducts in a manner observing the

bend radii and tension restrictions of the cable.

- K. The Contractor shall use appropriate shoes, guides, wheels and lubricants to prevent damage to the cable jacket and sheath during installation.
- L. Install shield bond connectors to the shields of all cables terminated at the Protector Panels.
- M. The Contractor shall apply an appropriate amount of damming compound over the end of filled copper cables in indoor or dry environments to prevent seepage of cable filling compounds where encapsulant shall not be used.
- N. Prior to closure assembly in dry or indoor installations, all exposed cable pairs shall have the filling compound thoroughly cleaned off the cable insulation using appropriate cleaning solvents.
- O. All pairs spliced shall be tested and all splice-related faults cleared prior to sealing the closure assembly.

3.2 BACKBONE CABLE TESTING

- A. Complete end-to-end test results for all copper UTP and fiber optic lines installed is required.
- B. All fiber optic cable must be visually inspected and optically tested on the reel upon delivery to the installation site. Using an Optical Time Domain Reflectometer (OTDR), an access jumper with like fiber, a pigtail, and a mechanical splice, all fibers shall be tested for continuity and attenuation. Testing for continuity and attenuation on the reel must confirm factory specifications to ensure that the fiber optic cable was not damaged during shipment. The test results must match the results of the factory-attached tag on the reel, or the fiber shall not be used. Reel data sheet must be provided showing test results.
- C. End to end (bi-directional) test measurements shall be provided for singlemode and multimode fibers (2 wavelengths per test are required). Test results must be submitted for review as part of the installation inspection requirements. Test results shall be in paper form and electronic form, and must contain the names and signatures of the technicians performing the tests.
- D. Testing shall be performed on 100% of the fibers in the completed end-to-end system. ANSI/TIA/EIA-568-A, Annex H, provides the technical criteria and formulae to be used in fiber optic testing. Note however, that all UH fiber must be tested, rated and guaranteed for Ethernet GigaSPEED 1000B-X performance. Additionally, all fiber optic cable links must pass all installation and performance tests both recommended and mandated by the cable manufacturer.
- E. All multi-pair copper cable pairs installed shall be tested to TIA/EIA 568A, Category 3 or Category 6 equivalent performance specifications. In addition, provide loop resistance measurements in ohms and dB loss at 1KHz, 8KHz, and 256KHz.
- F. The Owner is to be notified at least 24 hours prior to testing to allow observation at the Owner's discretion. If the Owner confirms his intention to observe, a reasonable starting time shall be agreed upon. Should the Owner not be present at the scheduled commencement time, the Contractor may begin testing as scheduled.
- G. 100% of all pairs in backbone copper cables shall be tested for continuity and wire-map.
- H. Format: Test Results must be submitted in two (2) formats. First, must be original file(s) downloaded from tester. Second, the file must be cohesively placed in Excel format with the following fields: ER/TR RM # / RM # of drop / Port # / all relevant test information in as many

fields as necessary.

- I. Care, with reference to above format criteria, should be taken when recording the information in the tester, proper consistency with port identification is required.
- J. As- Built drawings must be submitted with .dgn or .dwg file extensions.
- K. Delivery: Test Results may be electronically submitted to the ITNO Department. Contact information shall be provided after contract is awarded and before project completion
- L. All test results are to be recorded and turned over to the Owner for checking.

3.2 CABLE AND TERMINATION PANEL LABELING

- A. Label the installed cables in accordance with Section 27 05 53

3.3 CABLE SUPPORT

- A. Provide cable supports and clamps to attach cables to backboards and walls.
 - 1. Attach horizontal and vertical backbone cables at 2 foot intervals using Owner approved supports; such as D-rings or jumper troughs utilized for wire management.
- B. Attach cables to manhole racks using Owner approved methods

3.3 AS-BUILT DRAWINGS

- A. Provide three (3) copies of E and three (3) copies of C size prints along with CADD files in .dwg or .dgn formats showing floor plans with room numbers and actual backbone cabling and pathway locations and labeling. The deliverable is required within 5 business days of final cable testing.
- B. Red Line Drawings: Contract must kept one (1) E size set of floor plans on site during work hours with installation progress marked and backbone cable labels noted. Contractor may be asked to produce these drawings for examination during construction meetings or field inspections.

END OF SECTION 271300

271323 – COMMUNICATIONS OPTICAL FIBER INTRABUILDING BACKBONE CABLING

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 27 00 00: Communications General.
- B. Section 33 82 23: Optical Fiber Communications Distribution Cabling.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2002.

1.3 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.4 DESIGN REQUIREMENTS

- A. The Information Transport System backbone cabling system shall be designed to conform to the requirements of ANSI/EIA/TIA-568-B. In conformance with this standard, the cabling system shall be designed in a hierarchical star topology.
- B. The preferred fiber cable is Corning MIC optical fiber cable. This cable shall be armored or shall be routing in conduit, innerduct or steel raceway. Substitutions to this cable shall be pre-approved by the Owner. Submit all specifications for substitution candidate to the Owner's contact prior to specification.
- C. Optical fiber cables shall meet or exceed all applicable national and local building fire code requirements. Fiber cables used in a return air plenum environment shall have an Underwriters Laboratories rating that meets or exceeds the requirements of NFPA 262-1985 and UL®-910. (OFNP) and (UL®) shall be printed every two (2) feet on the cable jacket. The optical fiber riser cable shall have an Underwriters Laboratories rating that meets or exceeds the requirements of UL®-1666 (OFNR) and (UL®) shall be printed every two (2) feet on the cable jacket.
- D. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this specification. The attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable. No nominal values will be acceptable.
- E. Connections between any fiber optic patch panels shall be made with a pre-manufactured, fiber optic patch cord. All fiber optic jumper assemblies shall comply with the standards for both fiber optic cables and fiber optic connectors.
- F. Fiber shall be installed with strain relief as outlined by BISC1 methodologies.
- G. A service loop of 20 feet is required at each MDF and ER location. A service loop of 10 feet is required at all IDF locations. Service loops shall be neatly secured a minimum of eight feet above floor level on an adjacent wall within the communications room.

- H. Secure the cable to the cable tray using Velcro cable ties.
- I. Secure the cable to the wall to prevent horizontal movement of the cable (D-rings are acceptable). Secure the cables to the wall in a non-deforming manner to prevent vertical movement of the cable.
- J. Optical fiber intra-building backbone cables run entirely within stacked network rooms, within metallic conduit, or within innerduct can be unarmored. Otherwise, the cables shall be armored, including cables run in open raceways.
- K. Multi-Mode Fiber Characteristics
 - 1. All specified multi-mode fiber optic cable shall meet the following grade, attenuation and bandwidth characteristics.
 - a. 50/125 micron, OM4 grade, Graded Index
 - (1) 3.0 dB/km @ 850 nm Maximum attenuation
 - (2) 1.0 dB/km @ 1300nm Maximum attenuation
 - (3) 500 MHZ km @ 850nm Minimum bandwidth
 - (4) 500 MHZ km @ 1300nm Minimum bandwidth
- L. Single mode Fiber Characteristics
 - 1. All specified single-mode fiber optic cable shall meet the following grade, attenuation and bandwidth characteristics.
 - a. 8.3 to 9/125 micron
 - b. 1.0 dB/km @ 1310 nm and 1550nm Maximum attenuation
 - 2. The termination panels/connectors for single mode fiber shall be blue in color.
- M. Terminations and Connectors for Fiber Optic Cable
 - 1. Each strand of optical fiber cable shall be terminated with factory installed, LC connectors with field fuseable or Uni-cam pigtails. Terminate the fiber on a rack mounted patch panel.
 - 2. Typical loss shall not exceed 0.2 dB with a maximum loss of 0.4 dB per connector using LC type connectors. Durability shall not be less than 0.2 dB change over 100 rematings

PART 2 PRODUCTS

2.1 MATERIALS

- A. For all cables, specify plenum rated as required.
- B. Cable may be single mode-multimode hybrid cables where both fiber types are in a common outer sheath.

- C. Multimode, 50/125 micron, OM4 tight buffered, plenum:
 - 1. Corning Cable Systems
 - a. Premise Distribution Tight Buffered, MIC, aqua
 - b. Premise Distribution Tight Buffered, MIC, interlocking armored, aqua
 - 2. Commscope/Systimax Cable Systems
 - a. Premise Distribution Tight Buffered, MIC, aqua
 - b. Premise Distribution Tight Buffered, MIC, interlocking armored, aqua
- D. Single mode, 9/125 micron, tight buffered, plenum:
 - 1. Corning Cable Systems
 - a. Premise Distribution Tight Buffered, MIC, yellow
 - b. Premise Distribution Tight Buffered, MIC, interlocking armored, yellow
 - 2. Commscope/Systimax Cable Systems
 - a. Premise Distribution Tight Buffered, MIC, yellow'
 - b. Premise Distribution Tight Buffered, MIC, interlocking armored, yellow

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. In the MDF/IDF the Contractor shall provide at least 10 feet of cable in a wall mounted service loop just above the cable tray.
- C. In large telecommunications enclosures, the Contractor shall provide a service loop/coil of up to 10 feet as able to contain within the enclosure.
- D. The Contractor shall secure the cable to the cable tray using Velcro cable ties.
- E. The Contractor shall secure the cables to the wall to prevent horizontal movement of the cable (D-rings are acceptable). The Contractor shall secure the cables to the wall in a non-deforming manner to prevent vertical movement of the cable.
- F. The Contractor shall install fiber optic cable in conduit, cable tray or supported from building structure at 3 feet OC.
- G. All optical fiber cables are to be continuous and without splicing. Optical fiber based MUTOAs are not considered splices.
- H. Comply with manufacturers' recommendations regarding pulling tension and allowable

- lubricants.
- I. The Contractor shall be responsible for verifying actual footages and distances identified on attached prints (i.e. wall-to-wall, pullbox-to-pullbox and ER to network room).
 - J. The Contractor shall be responsible for verifying that conduits and raceways ready for occupancy before cable placement.
 - K. The Contractor shall assume responsibility for difficulties or damage to cable during placement.
 - L. Where fiber optic cable passes through vertical riser space or network rooms, secure fiber to wall vertically every 36 inches. Review fasteners, strain relief and routing with owner.
 - M. The Contractor shall test and label all cables.

END OF SECTION 271323

SECTION 271500 – COMMUNICATIONS HORIZONTAL CABLING

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. UTP cabling.
2. 50/125-micrometer, optical fiber cabling.
3. Coaxial cable.
4. Multiuser telecommunications outlet assemblies.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management System.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.

- G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.
- H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- I. RCDD: Registered Communications Distribution Designer. J.
UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For coaxial cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration drawings and printouts.
 - 4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - 5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Patch-Panel Units: One of each type.
 - 2. Connecting Blocks: One of each type.
 - 3. Device Plates: One of each type.
 - 4. Multiuser Telecommunications Outlet Assemblies: One of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

PART 2 PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Belden Inc.
 - 2. Berk-Tek; a Nexans company.
 - 3. CommScope, Inc.
 - 4. Draka Cableteq USA.
 - 5. Genesis Cable Products; Honeywell International, Inc.
 - 6. Mohawk; a division of Belden Networking, Inc.
 - 7. Superior Essex Inc.
 - 8. SYSTIMAX Solutions; a CommScope, Inc. brand.
 - 9. 3M Communication Markets Division.
 - 10. Tyco Electronics Corporation; AMP Products.
- C. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6A.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG[; or MPP, CMP, MPR, CMR, MP, or MPG.
 - b. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.

- c. Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, complying with UL 1666.
- d. Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG.
- e. Multipurpose: Type MP or MPG; or MPP or MPR.
- f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
- g. Multipurpose, Riser Rated: Type MPR or MPP, complying with UL 1666.

2.5 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. ADC.
 - 2. American Technology Systems Industries, Inc.
 - 3. Belden Inc.
 - 4. Dynacom Inc.
 - 5. Hubbell Premise Wiring.
 - 6. Leviton Commercial Networks Division.
 - 7. Molex Premise Networks; a division of Molex, Inc.
 - 8. Panduit Corp.
 - 9. Siemon Co. (The).
 - 10. Tyco Electronics Corporation; AMP Products.
- C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- D. Connecting Blocks: 110-style IDC for Category 6A. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
- G. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- H. Patch Cords: Factory-made, four-pair cables in 36-inch (900 mm) lengths; terminated with eight-position modular plug at each end.
 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.

2.6 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Belden Inc.
 2. Berk-Tek; a Nexans company.
 3. CommScope, Inc.
 4. Corning Cable Systems.
 5. CSI Technologies Inc.
 6. General Cable Technologies Corporation.
 7. Mohawk; a division of Belden Networking, Inc.
 8. Superior Essex Inc.
 9. SYSTIMAX Solutions; a CommScope, Inc. brand.
 10. 3M Communication Markets Division.
 11. Tyco Electronics Corporation; AMP Products.
- C. Description: Multimode, 50/125 micrometer, 24 -fiber, nonconductive, tight buffer, optical fiber cable.
 1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA/EIA-568-B.3 for performance specifications.
 3. Comply with TIA-492AAAB for detailed specifications.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - a. General Purpose, Nonconductive: Type OFN or OFNG[, or OFNR, OFNP].
 - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - c. Riser Rated, Nonconductive: Type OFNR[or OFNP], complying with UL 1666.
 - d. General Purpose, Conductive: Type OFC or OFCG[; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP].
 - e. Plenum Rated, Conductive: Type OFCP[or OFNP], complying with NFPA 262.
 - f. Riser Rated, Conductive: Type OFCR[; or OFNR, OFCP, or OFNP], complying with UL 1666.
 5. Conductive cable shall be steel armored type.
 6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5dB/km at 1300 nm.
 7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- D. Jacket:
1. Jacket Color: Aqua for 50/125-micrometer cable
 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.7 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. ADC.
 2. American Technology Systems Industries, Inc.
 3. Belden Inc.
 4. Berk-Tek; a Nexans company.
 5. Corning Cable Systems.
 6. CSI Technologies Inc.
 7. Dynacom Inc.
 8. Hubbell Premise Wiring.

9. Molex Premise Networks; a division of Molex, Inc.
 10. Siemon Co. (The).
- C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- D. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.
- E. Cable Connecting Hardware:
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
 3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.8 COAXIAL CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Alpha Wire Company.
 2. Belden Inc.
 3. Coleman Cable, Inc.
 4. CommScope, Inc.
 5. Draka Cableteq USA.
- C. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- D. RG-11/U: NFPA 70, Type CATV.
1. No. 14 AWG, solid, copper-covered steel conductor.
 2. Gas-injected, foam-PE insulation.
 3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 4. Jacketed with sunlight-resistant, black PVC or PE.

5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
- E. RG59/U: NFPA 70, Type CATVR.
1. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
 2. Gas-injected, foam-PE insulation.
 3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
 4. Color-coded PVC jacket.
- F. RG-6/U: NFPA 70, Type CATV or CM.
1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam- PE insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 3. Jacketed with black PVC or PE.
 4. Suitable for indoor installations.
- G. RG59/U: NFPA 70, Type CATV.
1. No. 20AWG, solid, copper-covered steel conductor; gas-injected, foam- PE insulation.
 2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
 3. PVC jacket.
- H. RG59/U (Plenum Rated): NFPA 70, Type CMP.
1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 3. Copolymer jacket.
- I. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
1. CATV Cable: Type CATV, or CATVP or CATVR.
 2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

3. CATV Riser Rated: Type CATVR; or CATVP, CATVR, or CATV, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.9 COAXIAL CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Emerson Network Power Connectivity Solutions.
 2. Leviton Commercial Networks Division.
 3. Siemon Co. (The).
- C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.10 CONSOLIDATION POINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. American Technology Systems Industries, Inc.
 2. Belden Inc.
 3. Chatsworth Products, Inc.
 4. Dynacom Inc.
 5. Hubbell Premise Wiring.
 6. Molex Premise Networks; a division of Molex, Inc.
 7. Ortronics, Inc.; a subsidiary of Legrand Group.
 8. Panduit Corp.
 9. Siemon Co. (The).
- C. Description: Consolidation points shall comply with requirements for cable connecting hardware.
 1. Number of Terminals per Field: One for each conductor in assigned cables.
 2. Number of Connectors per Field:
 - a. One for each four-pair UTP cable indicated.

- b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
3. Mounting: Wall.
4. NRTL listed as complying with UL 50 and UL 1863.
5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.11 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Belden Inc.
 2. Chatsworth Products, Inc.
 3. Hubbell Premise Wiring.
 4. Molex Premise Networks; a division of Molex, Inc.
 5. Ortronics, Inc.; a subsidiary of Legrand Group.
 6. Panduit Corp.
 7. Siemon Co. (The).
- C. Description: MUTOAs shall meet the requirements for cable connecting hardware.
 1. Number of Terminals per Field: One for each conductor in assigned cables.
 2. Number of Connectors per Field:
 - a. One for each four-pair UTP cable indicated.
 - b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
 3. Mounting: Recessed in ceiling.
 4. NRTL listed as complying with UL 50 and UL 1863.
 5. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
 6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.12 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: 6-port-connector assemblies mounted in single faceplate.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 - 3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 4. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.
 - 5. Legend: Machine printed, in the field, using adhesive-tape label.
 - 6. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.13 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

2.14 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.15 CABLE MANAGEMENT SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Ortomics Corporation, Inc.
 - 2. Chatsworth
- C. Description: Computer-based cable management system, with integrated database and graphic capabilities.
- D. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.
- E. Information shall be presented in database view, schematic plans, or technical drawings.

1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

F. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.16 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1. C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.
- E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- F. Cable will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
 3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.

13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- D. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
 2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
- G. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).
- H. Group connecting hardware for cables into separate logical fields.
- I. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Administration Class: 4.
 - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration, including optional identification requirements of this standard.
- E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- G. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 2. Visually confirm Category 6a, marking of outlets, cover plates, outlet/connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

- a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568- B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568- B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
6. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

- a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 271500

SECTION 271619 – PATCH CORDS, STATION CORDS AND CROSS-CONNECT WIRE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Copper and fiber optic patch cables.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 00 - Common Work Results for Communications

1.3 SUMMARY

- A. This Section specifies the requirements for the Patch Cords, Station Cords, and Cross-Connect Wire.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Ortronics
- B. CommScope
- C. Panduit

2.2 COPPER PATCH CABLES

- A. Two (2) Category 6 copper patch cables shall be furnished and installed for each horizontal cable installed as follows:
 - 1. 60% - 5 feet in length;
 - 2. 40% - 7 feet in length.
- B. Field terminated patch cables are strictly prohibited.
- C. At minimum, every horizontal cabling permanent link in the installation shall meet or exceed performance characteristics of the field test specifications defined in ANSI/TIA/EIA-568-B.2-1 "Transmission Performance Specifications for 4-pair 100 ohm Category 6 Cabling".
- D. Copper patch cables shall be labeled with the switch and port number on the patch panel end, and the patch panel and port number on the switch end.
- E. Patch cables color corresponds to the following:

1. Blue for Data or as required by Owner
2. Yellow for Wireless Access Points; or as required by Owner
3. Green for Building Energy Management and Environmental Controls Systems; or as required by Owner.

2.3 FIBER OPTIC PATCH CABLES

- A. Furnish and install one duplex LC Fiber optic patch cable for each fiber optic termination. Length to be determined and included in submittal documents.
- B. Fiber optic patch cables types shall coincide with terminated fiber optic type (ie. Singlemode or 50 μ m Multimode)
- C. Fiber Optic Patch Cable Color:
 1. Single-mode - Yellow; or as required by Owner
 2. Multi-mode - Orange; or as required by Owner
- D. Field terminated patch cords are strictly prohibited
- E. Patch cord shall be labeled on each end specifying the source and destination of the cable.

PART 3 EXECUTION

3.1 PATCH CABLES

- A. Cable Contractor shall fully cooperate and coordinate with Owner's Voice and Data Communications Equipment providers as required to ensure proper integration and connectivity between systems.
- B. Care shall be taken to protect the minimum bend radius of 4 times the cable diameter on all copper patch cables.
- C. Cable Contractor shall furnish labeled floor plan and Microsoft Excel run sheet to Owner's Voice and Data Communications Equipment providers two weeks prior to occupancy.
- D. Cable Contractor shall furnish and install all patch cords in conjunction with Owner's Voice and Data Communications Equipment providers.
- E. Cable Contractor shall provide adequate technician support when Owner's Voice and Data Communications Equipment providers are planning and installing new voice and data equipment installation and connectivity.

END OF SECTION 271619

271800 – COMMUNICATIONS TESTING

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 27 00 00; Communications General.

1.2 REFERENCES

- A. See Architectural Section - Reference Standards.

1.3 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.4 SUBMITTALS

- A. The Contractor shall provide the Owner's Representative with printed and electronic forms of all test results. Test results shall be unedited and as presented by the tester software. With the test results, the contractor shall provide software from the tester manufacturer to enable viewing of test results in native format. If software is not available, test results may be provided in comma-delimited text format. This must be pre-approved by JH.

1.5 PROJECT CONDITIONS

- A. The Owner's Representative reserves the right to be present during all testing.
- B. Testing of existing and active connections may be restricted until after normal working hours. The Owner's Personnel shall determine if testing can occur during normal business hours.
- C. Testing shall take place only when the channel is fully installed. If channel components may be moved or re-positioned after testing, the Contractor shall delay testing until cables, faceplates, and other components are in their final positions. This includes any repositioning by other trades prior to occupancy by the owner.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor shall perform validation testing on all voice and data communications cable installed as part of any project. This testing shall verify that the cable has been installed properly and has the specific characteristics required by the project.
- B. The Owner's Representative reserves the right to be present during any testing.
- C. The Contractor shall provide all required test equipment and personnel necessary to support the certification and validation tests prescribed in this section.

- D. The Contractor shall provide a listing of the test equipment proposed for use for all certification testing.

3.2 HIGH PAIR COUNT COPPER CABLES

- A. The Contractor shall provide a continuity test for all voice pairs. All voice grade copper cable shall be tested by toning-out each pair.
- B. The Contractor shall provide the Owner's Representative with printed and electronic forms of all test results. Test results shall be unedited and as presented by the tester software.

3.3 CATEGORY 6 COPPER CABLES

- A. All category 6 field testing shall be performed with an approved level III balanced twisted-pair field test device.
- B. All installed category 6 channels shall perform equal to or better than the minimum requirements as specified by the current ANSI/TIA/EIA standards for Category 6. If the cable manufacturer has a separate, more stringent set of test standards required to certify the total solution being installed, the Contractor shall use the more stringent requirements.
- C. Category 6 balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft.) for the basic link, and 100 m (328 ft) for the channel shall be 100 percent tested according to ANSI/TIA/EIA-568-B.2. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
- D. The Contractor shall provide JHU with printed and electronic forms of all test results. Test results shall be unedited and as presented by the tester software. With the test results, the contractor shall provide software from the tester manufacturer to enable viewing of test results in native format. If software is not available, test results may be provided in comma-delimited text format. This must be pre-approved by JH.

3.4 CATEGORY 6A COPPER CABLES

- A. All category 6A field testing shall be performed with an approved level III balanced twisted-pair field test device.
- B. All installed category 6A channels shall perform equal to or better than the minimum requirements as specified by the current ANSI/TIA/EIA standards for Category 6A. If the cable manufacturer has a separate, more stringent set of test standards required to certify the total solution being installed, the Contractor shall use the more stringent requirements.
- C. Category 6A balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft.) for the basic link, and 100 m (328 ft.) for the channel shall be 100 percent tested according to ANSI/TIA/EIA-568-B.2. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
- D. The Contractor shall provide the Owner's Representative with printed and electronic forms of all test results. Test results shall be unedited and as presented by the tester software. With the test results, the contractor shall provide software from the tester manufacturer to enable

viewing of test results in native format. If software is not available, test results may be provided in comma-delimited text format. This must be pre-approved by JH.

3.5 COAXIAL CABLES

- A. The Contractor shall test all coaxial cables per ANSI/SCTE ANSI/SCTE 15 2001 (Formerly IPS SP 100). Tests shall include characteristic impedance, conductor resistance, velocity of propagation (VOP), structural return loss (SRL), and attenuation from 5 - 1000 MHZ.

3.6 COPPER TEST EQUIPMENT

- A. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
- B. The Contractor shall set the testers to the correct cable, by manufacturer and name, to ensure correct parameters are used during testing. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.

3.7 FIBER OPTIC TESTING

- A. The Contractor shall test all optical fiber strands for insertion loss and length. The Contractor shall perform bi-directional OTDR tests on all OSP optical fiber strands.
- B. The Contractor shall test insertion loss at 850 nm and 1300 nm for 50/125m multimode cabling in at least one direction using the Method B (1-jumper) test procedure as specified in ANSI/TIA/EIA-526-14A.
- C. The Contractor shall test insertion loss at 1310 and 1550 for single model cabling in at least one direction using the Method A.1 (1-jumper) test procedure as specified in ANSI/TIA/EIA-526-7.
- D. The Contractor shall determine and record length using an OTDR, optical length test measurement device or sequential cable measurement markings.
- E. The Contractor shall calculate the allowable attenuated loss based on final installed length, attenuation coefficient, and connector loss.
- F. The Contractor shall remediate any strands testing above calculated limit.
- G. The Owner's Representative reserves the right to have third party testing to confirm the test results. The Contractor shall remediate, at their expense, any strands exceeding this limit by third party testing.
- H. The Contractor shall provide the Owner's Representative with electronic forms of all test results. Test results shall be unedited and as presented by the tester software.

3.8 FIBER TEST EQUIPMENT

- A. All optical fiber test equipment shall be factory calibrated as recommended by the field test equipment manufacturer. The calibration certificates shall be provided for review prior to the start of testing.

3.9 BONDING AND GROUNDING

- A. All bonds installed by the contractor shall be tested for impedance with an earth ground resistance test in its two-point setup, such as a LEM Handy GEO tester. The Contractor shall place a QA label (with date and inspector) in proximity to each bond tested.
- B. The Contractor shall test all grounding conductors, once installed, for current. The Contractor shall measure AC and bi-directional DC current. The Contractor shall report any AC current over 1 Amp. The Contractor shall report any DC current, in either direction, over 500milliamps.
- C. Test all bonds for a maximum impedance of 0.1 using a two-point impedance test. Contractors shall remediate any bond above 0.1 impedance.
- D. Test all bonds for a maximum impedance of 0.1 using a two-point impedance test. Contractors shall remediate any bond above 0.1 impedance.

END OF SECTION 271800

SECTION 272000 – DATA COMMUNICATIONS EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Data Communications Equipment.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 00 Common Work Results for Communications

1.3 SUMMARY

- A. Data Communications Equipment
 - 1. Data Communications Equipment includes customer owned routers, servers, Ethernet switches, personal computers, printers, wireless access points, etc. required to connect the Academic Wing to the rest of the campus, the internet and the public switched telephone network (PSTN).
 - 2. Data Communications Equipment is provided by Owner.
 - 3. Data Communications Equipment will be Owner Furnished Owner Installed (OFOI).
 - 4. Cable Contractor shall fully cooperate and coordinate with Owner as required to ensure proper integration and connectivity between systems.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 COORDINATION

- A. Cable Contractor shall fully cooperate and coordinate with Owner as required to ensure proper integration and connectivity between systems.
- B. Cable Contractor shall furnish labeled floor plan and excel run sheet to Owner two weeks prior to occupancy.
- C. Cable Contractor shall furnish and install all patch cords in conjunction with Owner.
- D. Cable Contractor shall provide adequate technical support to Owner during planning, installation and connectivity of new voice and data equipment.
- E. Cable Contractor shall provide adequate technician support first business day after data equipment installation and connectivity.

END OF SECTION 272000

SECTION 273000 – VOICE COMMUNICATIONS EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 00 Common Work Results for Communications

1.2 SUMMARY

- A. Voice Communications Equipment
 - 1. Voice Communications Equipment includes customer owned phones, faxes, etc. required to connect the building to the rest of the campus and the public switched telephone network (PSTN).
 - 2. Voice Communications Equipment is provided by Owner.
 - 3. Voice Communications Equipment will be Owner Furnished Owner Installed (OFOI).

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 Coordination

- A. Cable Contractor shall fully coordinate with Owner's Voice Communications Equipment provider as required to ensure proper integration and connectivity between systems.
- B. Cable Contractor shall furnish labeled floor plan and excel run sheet to Owner's Voice Communications Equipment provider two weeks prior to occupancy.
- C. Cable Contractor shall furnish and install all patch cords in conjunction with Owner's Voice Communications Equipment provider.
- D. Cable Contractor shall provide adequate technician support when Owner's Voice Communications Equipment provider are planning and installing new voice and data equipment installation and connectivity.
- E. Cable Contractor shall provide adequate technician support first business day after Voice equipment installation and connectivity.

END OF SECTION 273000

SECTION 280500 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. This document identifies the design and specification requirements for a complete and functional Electronic Safety and Security system to be performed for this project. The Electronic Safety and Security as specified herein will support the access control and various other low voltage devices.
- B. This Section, Requirements for Electronic Safety and Security Installations, applies to all sections of Division 28.
- C. The Architectural Plans and Specifications, General Conditions, Supplementary General Conditions and other requirements of Division 1, the Mechanical Plans and Specifications, the Electrical Plans and Specifications, and the Security Plans may apply to the work specified in the Division 28 Sections, and shall be complied with in every respect. The Contractor shall examine all of these documents, which make up the Contract Documents, and shall coordinate them with all security work on the Security plans and in the Division 28 specifications.
- D. Contract Documents: Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general the specifications determine the nature and quality of the materials, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the security system components. If there is an apparent conflict between the drawings and specifications, the items with the greater quantity or quality shall be estimated upon and installed. Clarification with the Owner or their designated representative about these items shall be made prior to bid response.
- E. The Architect may at any time, by written order, make changes within the general scope of any contract resulting from this proposal document. If such changes expand, reduce, change or modify the scope of work, the price for the change shall be increased or decreased at the unit prices set forth in the Unit Pricing Section, and the amount shall be deducted from, or added to, the sale price of the system to the Owner. No costs will be added to the project without prior written approval from the Architect.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 28 Sections include:
 - 1. 28 05 00 - Common Work Results for Electronic Safety and Security
 - 2. 28 05 26 - Grounding and Bonding for Electronic Safety and Security
 - 3. 28 05 28 - Pathways for Electronic Safety and Security
 - 4. 28 05 53 - Identification for Electronic Safety and Security

5. 28 06 00 Testing for Electronic Safety and Security

- C. Adherence to, and compliance with, the codes and standards referenced is mandatory. Requests to deviate from the standards and design solutions prescribed in these documents, on a case-by-case basis, in accordance with the instructions in the Policy and Procedures section of these guidelines. No deviation from the requirements of the National Electrical Code (NEC) will be allowed.

1.3 REFERENCES

A. Related Division 28 Sections include: (*Latest issue and addenda)

1. National Electric Code (NEC), Latest Issue
2. ADA Standards for Accessible Design 28 CFR Part 36
3. U.S. Department of Labor Occupational Safety & Health Administration (OSHA)
4. BICSI Electronic Safety & Security Design Reference Manual
5. ANSI/TIA/EIA568-B.1 - Commercial Building Telecommunications Cabling Standard*
6. ANSI/TIA/EIA568-B.2 - Commercial Building Telecommunications Cabling Standard*
7. ANSI/TIA/EIA568-B.3 - Optical Fiber Cabling Components Standard*
8. ANSI/TIA/EIA569 - Commercial Building Standard for Telecommunications Pathways and Spaces*
9. ANSI/TIA/EIA606-A - Administration Standard for Commercial Telecommunications Infrastructures, June 21, 2002*
10. ANSI J-STD-607-A, Commercial Building. Grounding/Bonding Requirements- Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications,2002* ANSI/TIA/EIA758-A - Customer-owned Outside Plant Telecommunications Infrastructure Standard, May 2005*
11. International Standards Organization/International Electro technical Commission (ISO/IEC) IS11801, 2000*
12. Underwriters Laboratories (UL) Cable Certification and Follow up Program*
13. National Electrical Manufacturers Association (NEMA)*
14. American Society for Testing Materials (ASTM)*
15. BICSI Electronic Safety & Security Design Reference Manual

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. The Security Contractor, here after referred to as “Contractor”, shall provide all materials, components, tools and labor necessary for the complete installation of all Electronic Safety and Security work required in the contract documents and specified herein.
2. The Communications Cabling Contractor, here after referred to as “Communications Contractor”, shall provide all materials, components, tools and labor necessary for the complete installation of all communications work required in the contract documents and specified herein.
3. The Electrical Contractor, here after referred to as “Electrical Contractor”, shall provide materials, components, tools and labor to complete the electrical power distribution.
4. Work furnished and installed by the Contractor as specified in Division 28 and as shown in E drawings includes:
 - a. Identification for Electronic Safety and Security Systems;
 - b. Electronic Safety and Security Systems Cabling;
 - c. Patch Cords, Station Cords, and Cross-Connect Wire;
 - d. Coordination with Communications Contractor;
 - e. Coordination with OFOI Communications Services;
 - f. Coordination with Wayfinding Guidelines.
5. Work under this Division not in contract (NIC) that will be Owner Furnished/Owner Installed (OFOI) includes:
 - a. include OFOI items
6. Work furnished and installed by the Electrical Contractor as specified in Division 28 and as shown in E and SC drawings includes:
 - a. The conduits and back boxes for the Electronic Safety and Security device outlets.
 - b. Electrical circuits for the Security rooms.
7. Work furnished and installed by others.
 - a. The new ER walls shall be covered with rigidly fixed $\frac{3}{4}$ ” marine plywood, void free, 8 ft high, and capable of supporting attached equipment and hardware. Plywood should be covered with two coats of fire retardant paint.

1.5 WORK RESULTS - DESCRIPTION OF PROJECT

A. Administrative Services

1. Contractor is required to provide test results and as-built documentation/record drawings prior to job acceptance. Refer to Section 28 06 00.

B. Grounding and Bonding for Electronic Safety and Security

1. Bonding conductors from the TMGB or TGB will be installed to all security equipment cabinets, equipment racks, raceway, cable ladder rack, cable tray, sleeves and conduits. Bond all TGBs to the TMGB per Section 28 05 26.
2. Bond TMGB to building ground per Section 28 05 26.
3. Final design and specifications for the Grounding and Bonding system shall be coordinated with the Electrical Engineer of Record.

C. Pathways for Electronic Safety and Security

1. VoIP Powered Devices

- a. The primary horizontal cable support system shall be conduit to cable tray and or J hooks, installed parallel to column lines. Wall penetrations shall transition to properly firestopped sleeves, then back to cable tray and or J hooks.
- b. Outlets having one single cable require a single gang box that routes to the cable tray via min. 1" conduit with pull string. Unless noted otherwise on drawings.
- c. Conduit runs may not be longer than 100ft or contain more than two 90 degree bends between pulling points, pull boxes or reverse bends without the use of a properly sized junction box. Insulated throat compression fittings must be used for security conduit runs, with termination points having plastic or grounding bushings installed.
- d. Riser sleeves in ER/TR must be properly installed with bushings and firestop. Provide Shop Drawings of all core drilling locations for coordination with Architect and Owner prior to drilling.
- e. All security conduits shall be provided with a measured pull tape.

2. Access Control Devices

- a. The primary horizontal cable support system for Access Control devices shall be conduit or dedicated cable tray or J hook pathway. Wall penetrations shall transition to properly firestopped sleeves, then back to cable tray and, or, J hooks.

D. Identification for Electronic Safety and Security

1. All cable labeling will be compliant with TIA/EIA606-A - Administration Standard for Commercial Telecommunications Infrastructures as described in Section 28 05 53.
2. All labeling will comply with Owner administrative labeling scheme of cabling and its numerical positions on the termination hardware. Ensure compliance with Owner's preferred administrative labeling standards.

E. Electronic Safety and Security Equipment Room Fittings

1. Contractor shall provide each ER/TR with proper equipment installed per Division 28 specifications and drawings.

F. Electronic Safety and Security Horizontal Cabling

1. Installed by Communications Contractor:

- a. Security camera cables will consist of plenum rated, Category 6, 4 pair UTP copper cables terminated on 48 port, RJ45, Category 6, 568B patch panels in the ER/TRs. The maximum horizontal distance shall be 295 feet.
 - b. Access control cables will consist of plenum rated, 4C 22AWG 2pr. (Installed by Communications contractor, unless noted on drawings)
 - c. Unless noted, provide proper plenum rated cabling for all Electronic Safety and Security equipment and devices- locations as detailed on the Security drawings.
2. Installed by Electrical Contractor:
- a. Security camera power cables will consist of plenum rated, 18AWG-2C, Low voltage cabling installed by Contractor). Unless noted on drawings, 16AWG-2C. High voltage cabling installed by Electrical Contractor.
- G. Termination Hardware
1. All Electronic Safety and Security cabling shall terminate in proper enclosures, back boxes, electronic devices per drawing, specifications, and manufacturer standards.
- H. Patch Cords, Station Cords, and X-Connect Wire
1. Contractor shall provide two (2) Category 6 patch cords per Security camera cable installed: 50% 5' length, 50% 3' length. (Provided by communications contractor)
- I. Data Communications Equipment
1. Data communications equipment will be OFOI.
- J. Network Connectivity for Other Trades: Communications Contractor will provide the following only for Division 28, unless noted on drawings.
1. Electronic Safety and Security –Copper and fiber cabling and termination hardware as required facilitating voice and data network connectivity for IP cameras, Emergency Call Towers, Access Control Panels. Refer to Security drawings and specifications for details.
 2. Fire Alarm –Copper or fiber connectivity as required for Fire Alarm Panels.
 3. Elevator Equipment Room – Copper connectivity to elevator equipment room(s). Coordinate with elevator equipment provider.
- K. Commissioning Administration
1. Contractor shall comply with General Commissioning Requirements of the Security infrastructure system.
- L. Project Meetings
1. Contractor shall attend preconstruction meetings with Project Team.
 2. Contractor shall provide representation on Project Team Meeting as specified in Division 1 and by the General Contractor as required.

3. Contractor will provide representation on the Commissioning Team as required for implementation of the Commissioning Plan.

M. Preconstruction Evaluation

1. Examination of buildings and site shall be the responsibility of the Contractor. Examine conditions for compliance with Electronic Safety and Security design specifications. Validate Security section is in accordance with related Contract Documents and the specified Owner's operational needs.

N. Construction Documentation

1. Contractor shall coordinate requirements with General Provisions specified in Division 1 - Construction Progress Documentation.
2. Contractor shall provide weekly progress report including synopsis of previous week's completed tasks, list of ongoing work, and updated schedule addressing milestones. Also include items for Owner coordination.
3. Contractor shall provide weekly report of inspection by project manufacturer certified installation firm to confirm Contractor's work is compliant with industry and manufacturer standards.

1.6 PROPOSAL SUBMITTALS

A. Follow Division 1 and this section.

B. A list of technical product education (training) completed by the Contractor's project personnel.

1. 100 percent of the on-site installation team members shall possess certification by Pelco Manufacturer as having completed the necessary training for installation, programming, and troubleshooting.
2. At a minimum, one (1) on-site personnel shall have appropriate Strand Video System training for installation, programming, and troubleshooting.
3. 100 percent of on-site installation personnel shall have BISCO certification in effect through the bidding process, installation, testing, documentation and acceptance. Documentation of all on-site personnel shall be provided post recommendation of selected contractor before final ITNO approval will be given.
4. Certificates shall be included in all responses to RFP/RFO documents.
5. Documentation of all on-site personnel shall be provided post recommendation before final ITNO approval will be given.

C. Price Quotation Information -

1. Submit Itemized Unit Pricing for Labor and Material.

D. The Contractor shall review this Section; Codes and Standards - Latest issue and addendums and state understanding and compliance or exception.

- E. Project schedule including all work components.
- F. Product Data: For each type of product indicated below. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.
 - 1. Submittals shall include the manufacturers cut sheets for the following:
 - a. Equipment enclosures and/or racks;
 - b. Electronic equipment/Devices;
 - c. Cables;
 - d. Connectors and termination hardware;
 - e. Protection hardware;
 - f. Fire stopping materials;
 - g. Test equipment to be used;
 - h. Cable support hardware.
- G. Product Data Manufacturer's literature sheets for all materials and equipment, including a copy of the proposed warranty, recommended preventative maintenance and spare part inventory recommendations. Literature containing more than one device shall be clearly marked to delineate item(s) included in the work. Clearly indicate color or special finishes.
- H. Manufacturer and Contractor statement of RoHS: Restriction of Certain Hazardous Substances Compliance.
- I. Design and Installation Certificates: Signed by local cable manufacturer's representative certifying that design is acceptable with cable manufacturer's Design Engineer(s) and Contractor is authorized by manufacturer to install registered (warranty) cabling system.
- J. A minimum of five (5) representative educational facilities security projects must be submitted as references to include the school's name, location, Architect or Engineer, cost of the security project and the contact person at the school district to include phone number.
- K. Submit written proof that the contractor is certified by the manufacturer of the products and adheres to the engineering, installation and testing procedures and utilizes the authorized manufacturer components and distribution channels in provisioning this Project.

1.7 SUBMITTALS

- A. Submit in accordance with Section 01 33 00, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Owner's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Owner to ascertain that the proposed equipment and materials

comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
1. Mark the submittals, "SUBMITTED UNDER SECTION _____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:
1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.

- d. Installation and maintenance instructions.
 - e. Safety precautions.
 - f. Diagrams and illustrations.
 - g. Testing methods.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
- 1. A 12 inch length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
 - 2. Each type of conduit and pathway coupling, bushing and termination fitting.
 - 3. Conduit hangers, clamps and supports.
- I. Duct sealing compound.

1.8 SUBMITTALS FOR PROJECT RECORD

- A. Follow Division 1 and this Section
- 1. Drawings: As-built documentation must be submitted five (5) business days prior to obtaining approval for cutover to any portion of the security system. Furnish for review and comments, 4 complete sets of E size (30 by 42) and 4 complete sets of C size as-built drawings along with 4 CDs containing all electronic AutoCAD 2000 or newer (DWG) files.
 - 2. Final approved Shop Drawings: Include plan and elevation of TRs, cable pathway details Backbone and horizontal, and cable locations and cable ID#, block diagrams, Interface requirements including connector types and pin-outs for all security equipment, Fabrication drawings for custom built equipment.
 - 3. Final approved Shop Drawings: One set shall be laminated and placed in appropriate ER/TR/ER.
 - 4. 4 sets of equipment /device inventory data must be submitted for all cable, termination hardware Submit data in binders and electronically on CDs in "Microsoft Excel" format, listing products furnished, including:
 - a. Manufacturer's name and part numbers.

- b. Cable numbers utilizing the Owner's cable numbering standard.
- 5. Manufacturer Certificates: Within 10 days of completion of the project, Contractor shall deliver letter signed by local Structured Cabling Components representatives and Contractor's RCDD stating that installed cabling system complies with all requirements specified in manufacturer's installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.
- 6. Test Reports: 4 sets of hard copies with 4 copies on CD in compliance with related Test Result Documentation.
- 7. Submitted test results and other submittals that are non-compliant will be reviewed and returned to the Contractor with comments.
- 8. Re-submitted test results and other submittals that are non-compliant will be reviewed and returned to the Contractor with comments.
- 9. Subsequent reviews of test results and other submittals will be performed jointly by the Contractor and the Communications Consultant and Contractor will pay Communications Consultant's published hourly rate during third review and thereafter.
- 10. Manufacturer's warranty to the Owner. This shall include, but is not limited to: Owner's name and project name and address. (Within three weeks of substantial completion).
- 11. Within 10 days of completion of the project, Contractor shall deliver letter signed by local SCS Manufacturers representative and Contractor's RCDD stating that installed cabling system complies with all requirements specified in installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.
- 12. Within 21 days of completion of the project, the communications contractor and/or the manufacturer's local representative will provide Owner the Performance Warranty signed by the manufacturer. The warranty shall list the owner and name of the facility, including location, as the holder of the warranty.

1.9 EQUIPMENT RELOCATION AND SYSTEM STARTUP

- A. Upon notice of construction completion, the selected Contractor will be responsible for system startup services for the new telecommunication room. The Contractor shall be responsible for ensuring the new equipment rooms, cabinets, floors and walls are clean and ready for equipment installation. On behalf of the Owner, the Contractor shall be responsible for coordinating with the GC and other trades to keep the ER and TRs clean and dust free at all times.
- B. It shall be the responsibility of the Contractor to develop and implement a full migration project schedule detailing the responsibilities of assigned personnel, along with contingency plans, and submit it to the Owner, or their designated representative, for approval.
- C. During the transition period, Contractor shall have the necessary supervisory, technical, and other personnel available throughout relocations and cutover of the Electronic Safety and

Security systems. This is to ensure that technicians are on site to observe the operation and maintenance of the equipment, and to resolve any related issues during system start-up.

- D. Contractor shall ensure all amenities are present prior to equipment relocation. Contractor shall immediately contact the Owner, or their designated representative, if a required service such as HVAC, electrical, UPS, etc., are not present.
- E. Contractor shall accomplish a smooth and successful transition of operations and services to the new telecommunication room. The transition includes the coordination, migration, testing, and problem resolution with the system vendors.

1.10 SEQUENCING AND SCHEDULING

- A. An initial planning meeting will be held with the successful bidder to clarify all requirements (systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that will transpire during the implementation of the project. Within two (2) weeks of the initial meeting, the Contractor shall provide a written report and project schedule to clearly document the events and responsibilities associated with the project.
- B. Contractor shall be responsible for the development and implementation of a complete project schedule detailing the responsibilities of assigned personnel and submit it to the GC and Owner for approval.

1.11 QUALITY ASSURANCE - CONTRACTOR QUALIFICATIONS

- A. Follow Division 1 and this Section.
 - 1. The Contractor shall possess the most recent version of the TIA/EIA 568 B Series Telecommunications Building Wiring Standards available from Global Engineering Documents.
 - 2. The Contractor shall possess at least one copy of BICSI Telecommunications Distribution Methods Manual, Eleventh Edition, or newer.
 - 3. Testing Technicians should possess manufacturer's certificates of completion for the test equipment used on the project.
 - 4. Untrained, undocumented, or otherwise unqualified personnel are not allowed to perform any portion of the Electronic Safety and Security installation.
 - 5. All personnel must be permanent employees of the contractor, or approved sub-contractors.

PART 2 PRODUCTS

2.1 PRODUCT SCHEDULE

- A. Refer to Division 28 sections for approved product and schedules.
 - 1. 28 05 00 - Common Work Results for Electronic Safety and Security
 - 2. 28 05 26 - Grounding and Bonding for Electronic Safety and Security
 - 3. 28 05 28 - Pathways for Electronic Safety and Security

4. 28 05 53 - Identification for Electronic Safety and Security
5. 28 06 00 - Testing for Electronic Safety and Security
6. 28 13 00 - Access Control

2.2 WARRANTY

- A. Network cabling warranty will be provided per Division 27.
- B. Provide a minimum (1) year warranty on all parts and labor.
- C. Provide an extended service agreement (3) year, with (5) year option, for parts and labor warranty at time of proposal.
- D. The Labor, Material and Performance Warranty shall cover the testing and replacement of all security equipment and cabling components. The structured cabling system shall be a complete certified system. The system and all components shall be performance matched and guaranteed by the manufacturer.
- E. Person / Entity Covered
 1. This warranty is for the sole benefit of Owner and any successor in interest to the site in which such Registered SCS was originally installed.
 2. All communications work and materials not included in the SCS components shall be warranted by the contractor that performed the work for a minimum of three years from the date of substantial completion.

2.3 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- D. Product Qualification:
 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 2. The University reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- E. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

F. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.
2. Manufacturer of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

G. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

H. When Factory Testing Is Specified:

1. The Owner shall have the option of witnessing factory tests. The contractor shall notify the Owner through the Construction Manager a minimum of 15 working days prior to the manufacturers making the factory tests.
2. Four copies of certified test reports containing all test data shall be furnished to Owner prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Owner.

2.4 EQUIPMENT REQUIREMENTS

- A. Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

2.5 LABELING

- A. Nameplates shall be laminated black phenol resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions
- B. Confirm administrative labeling scheme of cabling and its numerical positions on the termination hardware. Ensure compliance with Owner's preferred administrative labeling standards.

2.6 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.

2. Painted surfaces shall be protected with factory installed removable heavy Kraft paper, sheet vinyl or equal.
3. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas is not obvious.

PART 3 EXECUTION

3.1 SITE CONDITIONS

A. Existing Site Conditions

1. Cable pathways and runs to individual outlets are not shown in their entirety but shall be provided as if shown in their entirety. The Contractor shall coordinate with other trades to determine exact routing.

B. Environmental Limitations

1. Due to the critical nature of the environment, the Contractor shall use extra effort to provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation. Contractor shall remove all rubbish from job site daily at his or her own expense.

3.2 EXAMINATION

- A. Examination of buildings and site shall be the responsibility of the Contractor. Examine conditions for compliance with requirements of other sections in which related work is specified and determine if conditions affecting performance of the work of this Section are satisfactory. Do not proceed with work of this Section until unsatisfactory conditions have been corrected in an acceptable manner.
- B. Verify liquid-carrying pipes are not installed in or above Electronic Safety and Security equipment rooms.
- C. Verify fire-rated backboards are properly installed and painted following Section 06105. Notify the Project Manager immediately and prior to installation in the event that the backboards are not installed or painted properly.
- D. Verify conduit, raceways, and boxes are properly installed.
- E. Prior to starting the installation, the assigned installation supervisor shall participate in a walk-through of the project site with the Project Manager to review the installation documentation, verify that all construction necessary for the installation has been completed, and verify all installation methods and cable routes.
- F. The Contractor shall provide a complete installation according to the written specifications and drawings. If the scope of work to be performed by the Contractor changes, it shall be in writing.
- G. Contractor shall respond to these changes with a complete material list, including pricing, labor, and taxes in writing per Division 1 requirements. Contractor shall not proceed with additional scope of work without signed approval by the General Contractor.

3.3 PREPARATION

A. Protection of Surroundings

1. Repair: Patching and repair of facilities, finishes, and equipment. Any damage to building or site caused by Contractor, including grass, paving, curbs etc., shall be restored at Contractor's expense to match condition prior to damage. If necessary and requested by the General Contractor, Contractor shall provide professional services to clean or repair scratched/soiled finishes at their own expense.
2. Contractor shall keep all foods and liquids (water, drinks, etc.) in designated break areas.
3. The Contractor shall obtain the Architect's and Engineer's written permission via the General Contractor before proceeding with any work necessitating cutting into or through any part of building structures such as girders, beams, concrete or tile floors, partition and/or ceilings.
4. If it becomes necessary to cut through any wall, floor, or ceiling to install any work under this Section of the Contract or to repair any defects that may appear up to the expiration of the guarantee period, such cutting shall be done by the Contractor under the supervision of the General Contractor.
5. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades caused by cutting or by the failure of any part of the work installed under this Contract, shall be performed by the appropriate trade but shall be paid for by the Contractor.
6. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically approved by the Architect/Engineer.
7. All openings shall be restored to "as-new" condition under the appropriate Specification Section
 - a. For the materials involved, and shall match remaining surrounding materials and/or finishes.
8. Refer to Division 1 for additional information.

3.4 PRODUCT QUALITY ASSURANCE

- A. All materials and equipment provided shall be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacture of such products. All materials shall be typical commercial designs that comply with the requirements specified. All materials and equipment shall be readily available through manufacturers and/or distributors. All equipment shall be supplied complete with any optional items required for proper installation.
- B. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to correct and make the Electronic Safety and Security work in compliance with the applicable manufacturer written technical recommendations and standards.

3.5 DEMOLITION / REMOVAL

- A. Unless indicated otherwise, all items that must be removed due to interference with work of this contract remain the property of the Owner, and are to be salvaged at the Owner's discretion. Any material to be salvaged, other than Contractor's waste material, must be approved in writing by the General Contractor.

3.6 FIRESTOPPING.

- A. The Contractor is required to properly fire-stop any penetrations through fire barriers utilized for the placement of security cabling. Provide fire resistant intumescent materials to restore fire ratings to wall, floor, or ceiling penetrations according to local and national codes.
- B. Verify the hourly rating of the barrier.
- C. Select the UL Listing to match or exceed the barrier.
- D. Adhere to cable loads and fill procedure in the Listing.
- E. Seek pre-approval from the Authority Having Jurisdiction (Inspector).
- F. When installing the System, be sure not to exceed the listing limitations.
- G. After installation, place information labels and take digital photographs of both sides of each firestopped penetration in the System for future reference.
- H. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.
- I. Provide fire resistant materials to restore fire ratings to all wall, floor, or ceiling penetrations used in the distribution and installation for security cabling system. Coordinate fire stopping procedures and materials with General Contractor and Div.7.
- J. Solutions and shop drawings/submittals for fire stop materials and systems shall be presented to the General Contractor for written approval of materials prior to purchase and installation.
- K. Materials shall be installed per manufacturer instructions, be UL listed for intended use, and meet NEC codes for fire stopping measures.
- L. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and remain resilient and pliable to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.
- M. The fire stopping material shall maintain/establish the fire rated integrity of the wall/barrier that has been penetrated.
- N. Contractor shall coordinate with electrical contractor and ensure Security Pathway firestopping is properly identified and labeled. Contractor shall laminate and permanently affix to each side of a fire wall/floor penetration, the following information:
 - 1. Installing Contractor's name, address and phone number.

2. Alpha-numeric unique identifier (floor/penetration - A1)
3. Name of manufacturer of fire stop system.
4. Part & model numbers of system and all components.
5. Phone numbers of manufacturer's corporate headquarters in U.S. and local distributor's name and phone number.

3.7 CONSTRUCTION WASTE MANAGEMENT

- A. Contractor shall remove all excess material and debris from the site upon completion of work each day and in a manner approved by the General Contractor's Project Manager. See Division 1.

3.8 CLOSEOUT ACTIVITIES

- A. Acceptance shall be subject to substantial completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described herein.
 1. All Proposal Submittals and Project Record Submittals.
 2. Training to Owner's representative on methods to add and remove fire stop barriers, add and remove isolation conduit seals and add and remove IP 67 rated outlets.
 3. Maintenance manuals specified in Div. 1 to GC and Owner regarding structured cabling system, firestopping and conduit sealing methods and manufacturer's recommended maintenance instructions.
 4. Contractor shall complete all punch list items within five (5) days of notification by GC.
- B. Contractor shall wipe down all equipment, racks, cabinets, and sweep and mop ER/TR floors prior to Substantial Completion.
- C. Contractor shall complete Closeout Checklist listing status of all submittals, maintenance manuals, Owner training, and punch list items and deliver per Division 1.

3.9 SINGULAR NUMBER

- A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

3.10 TRAINING

- A. Training shall be provided for the particular equipment or system as required in each associated specification.
- B. A training schedule shall be developed and submitted by the contractor and approved by Owner at least 30 days prior to the planned training.

END OF SECTION 280500

SECTION 280526 – GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.
- D. Communication system grounding.
- E. Electrical equipment and raceway grounding and bonding.
- F. Control equipment grounding.

1.2 SUMMARY

- A. Work covered by this Section consists of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of grounding and bonding infrastructure as described on the Drawings and/or required by these specifications.

1.3 RELATED SECTIONS

- A. Refer to Section 28 05 00 for detailed information on scope of work.
- B. Refer to Section 28 05 53 for all labeling requirements.

1.4 DEFINITIONS

- A. MER - Main Equipment Room: The main room, which typically contains the PBX, MDF and main Data Communications equipment.
- B. ER - Equipment Room: Any additional room containing switches, hubs, patch panels and cross-connects away from a central location to serve areas out of distance from the MER.
- C. TO - Telecommunications Outlet: Point of connectivity for voice, data or video on the wall or in the floor. Refer to Telecommunications Drawings and Symbol sheet(s) for quantities and types of media at each outlet.
- D. MDF - Main Distribution Frame: A termination frame for unshielded twisted pair cable, usually providing a connection field for PBX telephone ports and feeder/riser cables to TR's. The MDF is normally located in the MER.
- E. IDF - Intermediate Distribution Frame: A termination frame for unshielded twisted pair cabling providing a connection field for horizontal wiring from the workstation and feeder/riser cables extended from the MER.

- F. TMGB - Telecommunications Main Grounding Busbar: The dedicated extension of the building grounding electrode system for the telecommunications infrastructure. Insert Project Name
- G. TGB - Telecommunications Grounding Busbar: The grounding connection point for telecommunications systems and equipment in the area served by an ER.
- H. TBB - Telecommunications Bonding Backbone: A bonding conductor that provides direct connection between the TGB's and TMGB.

1.5 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. B 3 Soft or Annealed Copper Wires
 - 2. B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
 - 3. B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 142-82 Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - 2. 1100 Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems.
- C. Underwriters' Laboratories (UL):
 - 1. 83 Thermoplastic Insulated Wire and Cables
 - 2. 96 Lightning Protection Components
 - 3. 96A System Installation
 - 4. 467 Grounding and Bonding Equipment
- D. National Fire Protection Association (NFPA):
 - 1. 780 Lightning Protection Code
 - 2. 70 National Electrical Code (NEC)
 - a. NEC Article No. 250 - Grounding
- E. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance (ANSI/TIA/EIA):
 - 1. J-STD-607-A Commercial Building Grounding and Bonding Requirements.
 - 2. Telcordia – Network Equipment Building Systems (NEBS) GR-1275.
- F. Building Industry Consulting Services International (BICSI):

1. Telecommunications Distribution Methods Manual
 2. Customer Owned Outside Plant Design Manual
- G. Local, county, state and federal regulations and codes in effect as of date of “notice to proceed” shall be complied with.

PART 2 PRODUCTS

2.1 GROUNDING BUSBARS

- A. Telecommunications Main Grounding Busbar (TMGB)
1. Chatsworth #10622-012 ground busbar with Chatsworth #10622-000 busbar insulators or equivalent.
- B. Telecommunications Grounding Busbar (TGB)
1. Chatsworth #10622-012 ground busbar with Chatsworth #10622-000 busbar insulators or equivalent.

2.2 GROUNDING JOINTS AND SPLICES

- A. Grounding conductor joints/splices shall be mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor equal to Burndy “QPX”, OZ/Gedney “XTP” or “PMX” or Penn Union “VX” or copper compression type with two (2) indents equal to Burndy, T&B or Blackburn.
- B. Grounding conductor terminations (lugs) shall be single barrel, mechanical screw type, copper alloy with machined contact surfaces equal to OZ type “SL”, T&B, or Burndy or copper compression type with two (2) indents equal to Burndy, T&B or Blackburn.

2.3 BONDING CONDUCTORS

- A. Cable Tray Bonding Conductor
1. Green #8 AWG insulated bonding jumper (12” max) with appropriate lugs or manufactured braided copper grounding jumper equal to B-Line #CAM-GJ, T&B #BD12, OZ/Gedney type “FB” or MonoSystems.
- B. Equipment Frame Bonding Conductor
1. Panduit #TRGK672 Telecommunications Rack Grounding Kit.
- C. Bonding Conductor (BC)
1. Green insulated copper bonding conductor, size as required by NEC.
 - a. The BC shall be, as a minimum, the same size as the TBB.
- D. Telecommunications Bonding Backbone (TBB)

1. Green insulated copper conductor, minimum size of No. 6 AWG. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Insulation shall meet fire ratings of its pathway.
 - a. Table 1
 - 1) Sizing of the TBB
 - 2) TBB length (ft) TBB Size (AWG)
 - (a) Less than 13 6
 - (b) 14-20 4
 - (c) 21-26 3
 - (d) 27-33 2
 - (e) 34-41 1
 - (f) 42-52 1/0
 - (g) 53-66 2/0
 - b. Greater than 66 3/0

PART 3 EXECUTION

3.1 TELECOMMUNICATIONS INSTALLATION

A. Installation of the TMGB

1. Install the TMGB at the bottom of plywood backboard near the outside plant entrance conduits in the "MDF".
2. TMGB shall be installed so that the BC for telecommunications is as short and straight as possible.
3. Conductor shall be installed in continuous 3/4" conduit.

B. Installation of the TGB

1. Install the TGB at the bottom of plywood backboard near the copper riser terminations in each "IDF".
2. TGB shall be installed so that the TBB for telecommunications is as short and straight as possible.

C. Installation of the TBB

1. Install Green insulated copper grounding conductor (refer to 2.03.D for conductor size) from the TMGB to each TGB.

D. Installation of Grounding Conductor Joints/Splices

1. Install mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor or copper compression type with two (2) indents.
2. Install manufactured insulating cover or heavy tape insulation over joints/splices.

E. Grounding of Cable Tray

1. Install Green #8 AWG bonding jumper (12" max) with appropriate lugs at each cable tray joint or install manufactured braided copper grounding jumper equal to B-Line #CAM-GJ, T&B #BD12, OZ/Gedney type "FB" or Mono-Systems.
2. Install Green #8 AWG grounding conductor with appropriate lugs from side of cable tray down to TMGB or TGB. Drill and tap side of cable tray (for appropriate size bolt, 1/4" x 20 min.), making sure that bolt does not extend into wire management part of tray.

F. Grounding of Equipment Frame

1. Install Panduit or equivalent Telecommunications Rack Grounding Kit from equipment frame to grounded cable tray, TMGB, or TGB.

END OF SECTION 280526

SECTION 280528 – PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior communications pathways and supports.
- B. Outlets and conduit runs.
- C. Risers in ER/TR(s).
- D. Grounding and bonding of pathways.
- E. Pathway fire stopping requirements.

1.2 RELATED SECTIONS

- A. Section 08 71 00 - Door Hardware.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 28 05 00 - Common Work Results for Electronic Safety and Security
- D. Section 28 05 26 - Grounding and Bonding for Electronic Safety and Security.
- E. Section 28 05 53 - Identification for Electronic Safety and Security.
- F. Section 28 06 00 - Testing for Electronic Safety and Security.
- G. Section 28 13 00 – Access Control.
- H. Section 28 16 00 – Intrusion Detection.
- I. Section 28 23 00 - Video Surveillance.
- J. Section 28 26 00 - Electronic Personal Protection System.
- K. Division 27 - Communications

1.3 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This Section specifies the requirements for the Security Pathways for Communications Systems.
- C. Conduit, cable tray and back boxes for this system shall be furnished and installed by the electrical contractor under the supervision of the security contractor.

- D. Security conduit must be properly designed and installed. The design and installation practices for Open Works.
- E. Security conduits have some unique requirements beyond those normally seen in standard electrical conduit.
- F. Work furnished and installed by Electrical Contractor as specified in this Section and as shown in E drawings includes:
 - 1. The conduits and back boxes for the device locations.
 - 2. Fire stopping of conduit cable pathway.
- G. Work furnished and installed by the Security Contractor as specified in this section and as shown in E drawings includes:
 - 1. Access Control, Intrusion Detection and Surveillance End Devices
 - 2. Cabling
 - 3. Hardware
 - 4. Software

PART 2 PRODUCTS

2.1 GENERAL

- A. Conduits must be designed and installed in the most direct route possible from the security room to the device location.
- B. The maximum length of LAN copper horizontal distribution cable is 90 meters (295 ft) from the device location to the TR or security room termination point, no exceptions. This applies in particular to IP based CCTV cameras or IP based card readers. Where this length would be exceeded the designer will need to add media converters or additional TR's as required.
- C. Security cabling is installed in a home-run fashion with individual cables running from the device location all the way to the security room. Splices in horizontal distribution cable are not allowed.
- D. Factory-manufactured sweeps which meet ANSI/TIA/EIA569-A bend radius requirements shall be used for all security conduit.
- E. The bend radius of the sweeps must be a minimum of 10- times the internal conduit diameter. Bending conduit in the field using manual or mechanical methods is not acceptable. Standard electrical elbows shall not be used. This sweep radius is necessary to insure that the conduits can accept future cabling. All horizontal conduit shall be tested by the conduit installation contractor with a mandrel to prove compliance with the sweep radius requirements throughout the conduit run.
- F. Each security back box shall have an individual conduit routing to the security room, or to the pull box or pulling point, connecting to a major cable pathway routing to the security room.

Box shall be located in serviceable space. Looping, or “daisy-chaining,” of conduits between outlet boxes is not allowed.

2.2 CONDUITS AND FITTINGS

- A. All conduit ends shall have plastic bushings installed before the cable is pulled into the conduit.
- B. Conduits will not be run next to hot water lines, steam pipes, or other utilities that may present a safety hazard or cause a degradation of system performance.
- C. Conduits entering the Security Room should be designed and located allowing for the most flexibility in the routing and racking of cables.
- D. Conduits or conduit sleeves entering through the floor of the Security Room shall terminate four (4) inches above the finished floor.
- E. All metallic security conduits entering the Security Room, Equipment Room, or Entrance Facility shall be bonded together, and bonded to the Main Grounding Busbar with a #6 AWG ground cable.
- F. All in-use and spare conduits entering the Security Room, Equipment Room, or Entrance Facility shall be sealed to prevent the intrusion of water, gasses, and rodents throughout the construction project. Within five days of releasing the conduit for the installation of cable, the conduit installation contractor shall prove all conduits to be clean and dry.
- G. All conduits and cables that penetrate fire rated walls or floors must be fire stopped.
- H. All OSP conduits and inner-duct, used and spare, shall be plugged with watertight plugs at both ends to prevent the intrusion of water, gasses, and rodents throughout the construction project.
- I. All OSP conduits shall have pull lines rated at a minimum of 90 kg (200 lb) pulling tension installed. The pull lines must be re-pulled each time an additional cable is installed.
- J. Prior to releasing the conduit for the installation of cables, all OSP conduits must be cleaned with a brush pulled through the conduit at least two times in the same direction and swabbed with clean rags until the rag comes out of the conduit clean and dry.
- K. All OSP conduits must be tested with a mandrel to prove compliance with the sweep radius requirements throughout the conduit run. Within five days of releasing the conduit for the installation of cable, the conduit installation contractor shall prove all conduits to be clean and dry.

2.3 INSIDE PLANT PULLBOXES

- A. Pull boxes used with security conduits in interior locations shall be rated NEMA-1. Pull boxes used in damp or wet locations such as plumbing chases or out of doors shall be rated NEMA-3R. Pull boxes shall be installed in conduits at an interval no greater than every 100 feet. Add appropriately sized pull box shall be installed in conduit runs whenever there are two 90°sweeps, or a total of 180°of sweeps, in a conduit run. Any deviations from these criteria must have prior approval from the Owner.

PART 3 EXECUTION

3.1 SUMMARY

- A. The Inside Plant (ISP) security substructure are the cable pathways and support structures necessary for routing security cabling between security rooms, and from the security room to the device location. There are numerous different products and methods that can be employed to build the substructure. Some of these methods include: Enclosed conduit system, open or enclosed cable trays, routing above a false ceiling using cable supports, and in-slab floor ducts. Security cable pathways shall be separate from IT pathways whenever and where ever possible, if it is necessary to route security cabling in the same cable pathway as IT cables a metallic divider must be installed between the cables.
- B. The conduit system shall be routed inside ceilings, floors, and walls to the greatest extent possible. Surface mounted conduit shall be used only when there is no other route to provide service to the desired location.
- C. For the main floor in, "slab on grade constructed buildings", conduit will route in walls and ceilings not in or under the slab. If this design is not possible, an alternate must be presented and approved following the "Approval for Alternate Design Solutions". If an under slab route solution is approved, the conduit must be installed with at least 1" of concrete encasement around all sides of the conduit.
- D. All device locations shall have a minimum ¾" conduit. Increase the conduit size as necessary for the quantity of cables to be installed. Cable fill shall not exceed 40% and plan on 25% growth.
- E. Security cable and conduit shall maintain the minimum separation distance from power as listed below.
 - 1. For power systems operating at 480V or greater, maintain a minimum separation distance of 3m (10 ft) from all security cabling. Pathways should cross perpendicular to electrical power cables or conduits. For large electrical motors or transformers, maintain a minimum separation distance of 1.2m (4 ft) from all security cabling.
 - 2. For lightning protection system conductors (NEC 800-13), maintain a minimum separation distance of 1.8m (6 ft) from all security cabling.
 - 3. For power systems operating at less than 480V, including all conduit and cables used for electrical power distribution, maintain a minimum separation distance of 0.6m (2 ft) from all security cabling. Pathways should cross perpendicular to electrical power cables or conduits.
 - 4. For branch circuits (secondary) power (120/240V, 20A) where electric light or power circuits coexist with security cabling, maintain a minimum separation distance of 2 in.

END OF SECTION 280528

SECTION 280544 – SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY
PATHWAYS AND CABLING

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.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- C. Section Includes:
 - 1. Wire-basket cable trays.
- D. Related Requirements:
 - 1. Division 26 Section "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.
 - 2. Division 27 Section "Communications Systems Grounding and Bonding".

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Field quality-control reports.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.5.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-BASKET CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Cablofil/Legrande.WBT
 - 2. Cooper B-Line
- C. Basis-of-Design Product Description:
 - 1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
 - 2. Materials: High-strength-steel longitudinal wires with no bends.
 - 3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.

4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch (3000mm) lengths.
 - b. Wire-Basket Depth: 4-inch (100-mm) usable loading depth. Width as indicated on drawings.
5. Sizes: Maximum Loads: 50 lb/ft. (74 kg/m).
6. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
7. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
8. Hardware and Fasteners: zinc plated according to ASTM B 633.

2.4 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 380.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.
 - a. Standard: Comply with ASTM A 653/A 653M, G90 (Z275).
 - b. Hardware: Chromium-zinc plated, ASTM F 1136.
5. Finish: Electrogalvanized before fabrication.
 - a. Standard: Comply with ASTM B 633.
 - b. Hardware: Galvanized, ASTM B 633.

2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Provide cable tray drop outs at locations where cables exit the open end of the cable tray and where cables exit the sides and/or bottom of cable tray.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- K. Support wire-basket cable trays with trapeze hangers.
- L. Support trapeze hangers for wire-basket trays with 1/4-inch diameter rods.
- M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Make large radius corners at "Tee" intersections and crosses. No sharp 90-degree corners.
- R. Make large radius sweeping bends at 90-degree corners. No sharp 90-degree corners.
- S. Seal penetrations through fire and smoke barriers. Comply with requirements in
 - 1. Division 07 Section "Firestopping."

- T. Install cable trays with a minimum workspace of 18-inches along one side to a minimum height of 12-inches above and over the cable tray for its full width to permit access for installing cables.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified.
 - 1. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems and Division 27 Section "Communications Systems Grounding and Bonding".
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with hook and loop cable ties according to NEMA VE 2. Secure the cable, without indenting the cable jacket.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 4. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
6. Check for improperly sized or installed bonding jumpers.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Inspect that bolt heads only are on the inside of the cable tray and correct those that are not.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 CABLE TRAY INSTALLATION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END SECTION 280544

SECTION 280553 – IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Documentation practices and requirements of cables, termination hardware, patching and cross connection facilities, conduits, other cable pathways, Security rooms, and other security spaces.

1.2 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. This Section specifies the requirements for the Identification for Communications Systems for Open Works.
- B. Work covered by this Section shall consist of furnishing labor, equipment and materials necessary for the labeling of the Electronic Safety and Security infrastructure and all security devices as described on the Drawings and/or required by these specifications.

1.4 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the latest applicable requirements of:
 - 1. ANSI/TIA/EIA - 606-A Administration Standards.
 - 2. ANSI/TIA/EIA - 569 Pathway and Spaces
 - 3. ANSI/TIA/EIA - 568-B Telecommunications Cabling Standard.
 - 4. BICSI Telecommunications Distribution Methods Manual.
 - 5. UL 969.

1.5 SECURITY ADMINISTRATION

- A. Administration of the security infrastructure includes documentation of cables, termination hardware, cross- connection facilities, conduits, other cable pathways, security rooms, and other security spaces.
 - 1. All security devices and cables shall be clearly marked using permanent means. The designation scheme must be consistent with the scheme in use on the campus where the work is being performed. The scheme shall be approved by the Owner prior to installation and use.
 - a. Each individual cable shall be clearly marked on both ends.

- b. Multi conductor cables shall have each conductor clearly marked.

1.6 RECORDS

- A. A record is a collection of information about or related to a specific element of the security infrastructure. Records must be maintained in a computer spreadsheet, or in a computer database. Paper records are encouraged, but are optional. A cable record is prepared for each cable. The record will show the cable name, and must describe the origin point and destination point of the cable. The cable record will record what services and/or connections are assigned to each conductor or strand. An equipment record is prepared for services distributed from a certain piece of equipment, such as a router, camera, DVR or a system such as data gathering panel.

1.7 DRAWINGS

- A. Drawings are used to illustrate different stages of security infrastructure planning, installation, and administration.
- B. Installation or Construction Drawings
 - 1. Installation or construction drawings are the plans that show the installer how the infrastructure is to be installed. The quality of the installation can be directly impacted by the level of detail in the installation drawings and written specifications. Installation drawings for the project shall, at a minimum, show pathway locations and routing, configuration of security spaces including backboard and equipment rack configurations, and wiring details including identifier assignments.
- C. As-built Drawings
 - 1. The as-built drawings graphically document the installed security infrastructure through floor plan, elevation, and detail drawings. In many cases, these drawings will differ from the installation drawings because of changes made during construction and specific site conditions. In the as-built drawings, the identifiers for major infrastructure components must be recorded. The pathways, spaces, and wiring portions of the infrastructure each may have separate drawings if warranted by the complexity of the installation, or the scale of the drawings. As-built drawings are a vital component of the security administration system, and must be kept current as adds, moves, and changes take place. Owner requires the installer to provide a complete and accurate set of as-built drawings.

PART 2 PRODUCTS

2.1 LABELS

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Approved Manufacturer:
 - 1. Brady Corporation
 - 2. Panduit
 - 3. Equivalent

PART 3 EXECUTION

3.1 IDENTIFICATION AND LABELING

- A. To be consistent with ANSI/TIA/EIA standards and industry practices, it is important that labeling be applied to all security infrastructure components. Labeling with the unique identifier will identify a particular component.
- B. Labels are generally of either the adhesive or insert type. All labels must be legible, resistant to defacement, and maintain adhesion to the application surface.
 - 1. Outside plant labels shall be totally waterproof, even when submerged.
 - 2. All labels shall be machine printed. Hand written labels are not acceptable.
 - 3. Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.
 - 4. Other types of labels, such as tie-on labels, may be used. However, the label must be appropriate for the environment in which it is used, and must be used in the manner intended by the manufacturer.
- C. Label all electronic devices, active and spare devices: Camera's, Code Blue phones/call boxes, Alarm system components and DVR and patch panel ports. Provide Card Reader labels on the junction box closest to the Card Readers.
- D. Where insert type labels are used provide clear plastic cover over label.
- E. All labeling shall be coordinated with the Owner prior to start date.
- F. The size, color, and contrast of all labels shall be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
- G. Labels shall be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and shall have a design life equal to or greater than that of the labeled component.

END OF SECTION 280553

SECTION 280600 – TESTING AND INSPECTIONS FOR SAFETY AND SECURITY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Deliverables
- B. Test Procedures
- C. Field Quality Control
- D. Manufacturer's Field Services
- E. Demonstration

1.2 DELIVERABLES

- A. It is essential for the Owner to receive all test results and as-built drawings prior to job acceptance. The test results must adhere to the following specifications, formats and delivery conditions:

1. Specifications

- a. Complete end-to-end test results for all copper STP, UTP and fiber optic cables installed are required.
 - 1) All fiber optic cable must be visually inspected and optically tested on the reel upon delivery to the installation site. Using an Optical Time Domain Reflectometer (OTDR), an access jumper with like fiber, a pigtail, and a mechanical splice, all fibers shall be tested for continuity and attenuation. Testing for continuity and attenuation on the reel must confirm factory specifications to ensure that the fiber optic cable was not damaged during shipment. The test results must match the results of the factory-attached tag on the reel, or the fiber shall not be used. Reel data sheet must be provided showing test results.
 - 2) End to end (bi-directional) test measurements shall be provided for single mode and multimode fibers (2 wave lengths per test are required). Test results must be submitted for review as part of the installation inspection requirements. Test results shall be in paper form and electronic form, and must contain the names and signatures of the technicians performing the tests.
 - 3) Testing shall be performed on 100% of the fibers in the completed end-to-end system. ANSI/TIA/EIA-568-A, Annex H, provides the technical criteria and formulae to be used in fiber optic testing. Note however, that all fiber must be tested, rated and guaranteed for Ethernet 1000B-X performance. Additionally, all fiber optic cable links must pass all installation and performance tests both recommended and mandated by the cable manufacturer.
 - 4) 100% of all pairs of copper cables shall be tested for continuity and wire-map.

2. Format

- a. Test Results must be submitted in both hard and soft copy in a format previously agreed to by the client.
 - b. As Built drawings must be submitted with .dgn or .dwg file extensions.
3. Delivery
- a. Test Results must be both hard copy and electronically submitted to the Owner. Contact information will be provided after contract is awarded and before project completion.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TEST PROCEDURES

- A. Install in accordance with manufacturer's instructions.

Field Test Reports: Upon completion and testing of the installed system, test reports shall be submitted in booklet form and electronic media showing all field tests performed on, and adjustments made to each/any component and all field tests performed to prove compliance with the specified owner/consultant for compliance with performance requirements at a pre-scheduled meeting.

1. Specific test and verification requirements by demonstration or test are as follows. Owner, or Owner's designated representative, reserves the right to witness any and all tests.
 - a. Following factory assembly and delivery, the security subcontractor shall individually test each component and sensor and verify the proper functioning of each component within a particular sub-system.
 - b. Following installation, individually test each component and sensor and verify the proper functioning of each component within a particular sub-system. Similarly test each sub-system until all detection zones, alarm assessment components, alarm reporting and display, and access control functions have been verified. Prior to final functional and operational tests of the system correct any deficiencies. After sub-system verification is complete, test the entire system to assure that all elements are compatible and function properly as a complete system.
 - c. Upon completion of the above outlined tests conduct a formal test to be known as the "System Operational Test", in which all components and sub-systems of the security system are demonstrated to operate together as a system. This test is to be performed over a continuous seventy-two (72) hour period. A formal test plan and test procedures for each portion of the test shall be prepared by the security subcontractor and submitted to the Owner/Architect for approval. The subcontractor must demonstrate that the security system components and sub-systems meet specification requirements in the "As-Installed" operating environment during the "System Operational Test". While no formal environmental testing is required, temperature, humidity and other environmental parameters should be measured and recorded. Include this data in the test report document for the "System Operational Test".

3.2 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Division 1.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Include services of technician to supervise installation, adjustments, final connections, system testing, and to train personnel.

3.4 DEMONSTRATION

- A. Demonstrate normal and abnormal modes of operation, and required response to each.
- B. Provide 8 hours of instruction each for two persons.
 - 1. Conduct instruction at project site with manufacturer's representative.

END OF SECTION 280600

SECTION 281300 – ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 ABBREVIATIONS

CCTV Surveillance and Recording System

OLS Offline Locking System

OS Operating System

AS Application Software

GUI Graphical User Interface LAN Local Area Network WAN Wide Area Network

TCP/IP Transmission Control Protocol / Internet Protocol

IE Internet Explorer (Microsoft)

OLE Object Linking and Embedding (Microsoft) OPC OLE for Process Control

HTML Hyper Text Mark-up Language

LDAP Lightweight Directory Access Protocol

CPU Central Processing Unit

CF Compact Flash

AMC Access Modular Controller

FP Finger-Print

EOL End Of Line resistor

1.2 SUMMARY

- A. The intent of this document is to outline the minimum requirements for the design, supply, delivery, installation, testing, commissioning and maintenance of the proposed Access Control System.
- B. The proposed Access Control System shall offer a highly efficient and automated solution that allows operators to quickly identify an alarm scenario.
- C. The proposed overall system design and operation shall be user friendly and only require minimum training to allow an operator to perform his daily routine with minimum supervision required.
- D. All proposed security field devices installation shall not only to operate functionally, they have also to blend with the interior design of the building. Installer shall liaise directly with the architect and/or interior designer to ensure such requirements are harmonized.

- E. The following sections shall provide a general overview of the operation for each of the systems.
- F. All interfaces within the Access Control System shall be based on TCP/IP network protocol connectivity over the corporate intranet/ internet/ LAN/WAN.
- G. The specifier shall ensure that the Access Control System must be expandable in the following areas:
 - 1. The system shall be designed to allow foreseeable organizational changes and procedural changes beyond current plans,
 - 2. Additional hardware units shall easily be added without any modification to the existing hardware, software and network configuration,
 - 3. All systems shall provide at least 10% spare for future expansion and connection.
- H. The Access Control System shall be a multi-tasking and multi-users based head end running on a distributed TCP/IP network.
- I. The system shall be designed to provide alarm gathering, monitoring, handling, reporting, full logging including the performance and activities of the operators within the secured areas of the building. It shall also provide monitoring and control of inputs and outputs both locally and remotely (e.g. in different Buildings).
- J. The system shall be a flexible and user-friendly workstation providing user(s) with a Graphical User Interfaces (GUIs) for alarm monitoring and control. Such GUIs shall be the core of the entire Access Control System that includes map viewer with alarm list and a Video Verification module for surveillance and recording video streams.
- K. The system shall be provided to control access into designated security controlled doors only by personnel with a valid access card or Identification- PIN and within valid time schedule. All access cards shall be authenticated against the central and/or local database before granting access.
- L. The system shall support credential enrollment via field readers connected to the LAC.
- M. Up to three cards can be assigned to a person.
- N. Instead of a card, a person can use an Identification-PIN for access request.
- O. The first card of each person can be used for the Offline Locking System (OLS), too.
- P. All designated security controlled doors shall be fitted with a suitable card reader and/or pin pad.
- Q. The included Offline Locking System (OLS) requires special terminals on each door of the OLS.
- R. All door access activities shall be logged into the central database. Any unauthorized attempt or invalid card used shall be reported to the ACCESS CONTROL SYSTEM, including door held and forced opened alarm as priority alarm transactions.

- S. With the Video Verification module, live images from the camera installed at the door location shall be displayed at Access Control System GUI during door alarm activation and access request. It shall also be possible to select live view of the camera to view the person's face before activating (manually unlocking the door via icon control on the GUI) and granting during door access request.
- T. The system shall also include a feature to display the last 5 access requests from an specified entrance with last name, first name, database picture, timestamp and event type (authorized, card is unknown, card is blocked, etc.)
- U. Reports shall always be readily available and owner shall be able to request for the reports on exactly what information from the report is required with the use of event filters

1.3 SCOPE OF WORK

- A. The scope of work for this sub-contract shall include design, procurement, installation and associated services for a fully operational Access Control System as per manufacturer's guidelines, codes described within this document, that provide central security management, integrated control and remote monitoring of the intended site, including the interfacing of all existing facilities.
- B. All necessary tools, equipment, hardware, software and software user licenses required as describe in this document for the complete installation of the Access Control System shall be supplied and installed under this sub-contract.
- C. All equipment necessary for the Gigabit Ethernet LAN networking installation such as, domain/application servers, PC workstations, fiber optic interfaces, routers, switches, hub, modem, fiber and copper patch cords and the like shall be supplied and installed by the successful specifier under this sub-contract.
- D. All equipment supplied by the successful specifier shall be installed, configured, programmed, tested and commissioned, as specified herein and shown on the sub-contract drawings and the equipment schedules. The Specifier shall supply all materials and services necessary for or incidental to the installation and commissioning of the systems.
- E. The entire Access Control System including all its hardware, peripherals, software and software licenses as specified within this document shall be supplied and provided as part of this sub-contract.
- F. All equipment within the Access Control System shall continue to operate for at least 2 hours in the event of main AC power failure. The specifier shall take in consideration the traffic loads and power consumption at each point of installation when determining the size of the Uninterrupted Power Supply (UPS) as backup power. Provision of the UPS shall be under the scope of this sub-contract.
- G. The extent of the sub-contract works shall include cabling necessary to interconnect the various security systems central equipment, hardware and devices and the like for it to provide the performance as specified in this sub- contract document.
- H. All cable enclosures including conduits, cable trays, ducts, wall boxes, termination panels and the like that are required to facilitate and complete the installation shall be supplied and installed as part of this sub-contract.

- I. The successful specifier shall liaise directly with the owner, main contractor; architect; civil engineer, interior designer; and other sub-contractors at site in coordination of the installation work.
- J. All installations carried out by the successful specifier shall conform to the national standards and code of practices.
- K. The successful specifier shall cooperate and work closely with the appointed site safety officer to ensure safe working environment at all times.
- L. The Specifier shall upon completion of the installation provide complete training with documentations on the configuration, operation and maintenance of the systems to the required operators assigned by the owner.
- M. The Specifier shall supply all training materials, operational manuals, as-built drawings, diagram, negatives, printed materials, magnetic and optical storage disk as specific in the sub contract document.
- N. All equipment, systems and materials furnished and installed in this sub contract shall be in accordance with the applicable National and Local standards.
- O. All components, parts, and assemblies supplied and installed by the Specifier shall be warranted against defects in material and workmanship for a period of at least 24 months which include parts and labor.

1.4 SYSTEM REQUIREMENTS

- A. The Access Control System shall be of open-architecture, PC-based system based on Windows Operating Systems, such as Windows XP, Windows 7 (32 and 64 bit, Enterprise), Windows Server 2008 (R2).
- B. The Access Control System shall comply to the strict regulation and adapting state-of-the-art security technologies, the highest level of reliability, and integrate to networking infrastructures such as the Intranet, Internet, LAN/WAN.
- C. The main function of the Access Control System shall be to control and monitor all designated access to the selected doors, areas or buildings.
- D. The Access Control System shall be of modular design providing the flexibility to allow the user to add or remove any components and/or controlled functions or in the event when operating requirements change or as system expands.
- E. The Access Control System provided shall contain all the features and requirements specified, but not limited to, in this document. The specifier shall highlight and update the owner of any new or special functionality that are useful and relevant to the user's application but not found in any part of this document.
- F. The proposed Access Control System shall provide the functions and specifications described in this document. In particular, the proposed access controller shall be equipped with all common interfaces such as, Ethernet and RS-485 for connection to the Access Control System server running the management software.
- G. The Access Control System shall allow control of door entry access both by a proximity card reader and from the Access Control System workstation.

- H. The proximity card reader shall also incorporate a numeric keypad to be used if Card and/or Pin number access configuration is desired.
- I. The Access Control System shall support up to four (4) different Wiegand card formats simultaneously. The number of each format supported shall be unlimited.
- J. A locally mounted door release push button shall be provided for purpose of exiting at selected doors as defined by the owner.
- K. For highly secured areas as defined by the owner, exit card reader shall be provided to allow an exact tracking of people going in & out the predefined area.
- L. All access doors shall have an emergency break-glass door release installed to unlock the door for exit in the event of emergency. In addition, all dedicated doors along the escape route shall automatically open during fire alarm activation.
- M. The Access Control System shall also be provided to elevator as indicated on the drawing.
- N. The specifier shall supply, install and configure the Access Control System management software.
- O. The Access Control System shall monitor and record in a logbook all movements and activities at each control point
- P. The Access Control System shall provide configuration and programming of access groups, where each access group contains a list of control points or access doors to which a card holder has authorized access.
- Q. The Access Control System shall provide configurable time schedules to have the flexibility for programming automatic locking and unlocking of any access controlled doors, as well as activating and de-activating of card holder settings for restricting any access groups from entering certain areas with the pre-programmed time model.
- R. The time schedule shall include holiday facilities to allow user programming for public holidays and user definable special holidays. All schedules shall be definable by day, hours and minutes.
- S. The Access Control System shall be designed such that any point of failure within the system shall not affect the normal operation of the other sub-systems. It shall continue to operate even if the connection with the management software is not present.
- T. The Access Control System management software provided shall allow card personalization. That is, it shall include a tool for designing badges that supports the importing of bitmaps, text and database fields, such as name or badge number for creating of corporate badge designs printable on a standard card printer that come with a Windows compliant printer driver.

1.5 ACCESS CONTROL SYSTEM SERVER STRUCTURE AND SYSTEM ARCHITECTURE

- A. The Access Control System server shall be provided and structured based on centralized server architecture.
- B. The CPU provided for the Access Control System server shall be reliable and robust in construction to perform all the necessary functions as described in this document relative to the management of all sub- systems.

- C. The CPU shall be micro-processor based, completed with adequate disk storage to service the total system requirements and shall be of an industrial standard type, having proven record in similar applications.
- D. Database for Access Control System shall reside within the same server hardware.
- E. All alarms processing, logging, operator's response, data entry/input, graphical user interface and other system operations and management functions shall be performed at the Access Control System workstations connected to the Access Control System network. The operating system shall preferably be Windows 7 (32, 64 Bit) Enterprise, Windows Server

2008 (32, 64 bit), Windows XP

- F. All Access Control System servers and workstations shall be connected using a standard IP network over the corporate Intranet or dedicated Internet/ LAN/WAN.
- G. Access Control System PC hardware requirements:
 - 1. Standard Windows PC for both server and client
 - 2. 4GHz CPU
 - 3. at least 4GB RAM
 - 4. Server: 20GB free disk space
 - 5. Client: 1 GB free disk space
 - 6. 100 Ethernet NIC (PCI)
 - 7. Graphical adapter with 1280 x 1024, 32 k colors
 - a. Resolution Support 1024 by 768
 - b. 1280 by 1024
 - c. 2048 by 768
 - d. 2560 by 1024
 - 8. CD/DVD ROM.
 - 9. I/O Expansion Option
 - 10. USB Keyboard and Mouse
- H. The Access Control System shall have a multi-level priority interrupt structure proven in multi-tasking and multi-client real time applications. Simultaneous alarms/events monitoring by multiple users, system supervision and history archiving shall be possible without degradation of any functionality specified system or operation
- I. The Access Control System shall allow the configuration for information access permissions, that is, user/operator profile for the access on the master records, the permissions shall restrict to,

1. read only
 2. read, write, change, and delete
 3. change the current location of persons
 4. change the access authorizations of persons
- J. The Access Control System shall allow the configuration for information access permissions, that is, user/operator profile for the access on event data, the permissions shall restrict to;
1. view own messages
 2. view all messages without personal data
 3. view all messages
- K. The Access Control System shall allow the configuration for information access permissions, that is, user/operator profile for the access to the Configuration dialog.
- L. The Access Control System shall allow the configuration for information access permissions, that is, user/operator profile for door management.
- M. Access Control System shall allow the configuration for information access permissions, that is, user/operator profile for the access on video applications and devices, the permissions shall restrict to,
1. Persons
 2. can use alarm verification
 3. can use video verification
 4. video devices
 5. can use the specified group(s) of cameras
 6. video functions
 7. can use live video
 8. can use the archive of video streams
 9. can record and export video streams
- N. The Access Control System server shall act as the source that provides time synchronization to all sub-systems.
- O. The Access Control System shall be designed such that any failure of any sub-systems shall not affect all the other sub-systems. This shall also apply to any loss of power supply or suffer a loss in communications due to a break in the communication loop. In any case, each sub-system shall continue to function in a fully operational state with no loss of functionality.

- P. The Access Control System shall have a modular structure that allow for future system expansion with minimum cost and disruption to the existing operational system. Such upgrade shall not make use of or compromise the spare requirement specified or utilizing or sharing any of its functions.
- Q. The Access Control System shall be expandable to support a limited number of 16 integrated operator workstations

1.6 ACCESS CONTROL SYSTEM APPLICATION

- A. Access Control System Application Software (AS) proposed shall be proven to be robust and reliable prior to being supplied, installed, tested and commissioned. It shall be user friendly and flexible enough to provide interactive operator prompting to assist operator who are not familiar with the system terminologies, operating system or menu structures, to be able to operate the system with ease and minimal training.
- B. The Access Control System AS proposed shall provide English descriptions and messages using both text based menus and graphical icon displays. Other languages shall also be supported in the standard version. These are German, Dutch, Russian, Spanish, Portuguese (Brazil), Polish, Chinese (PRC).
- C. The Access Control System AS shall be capable to support to the following:
 - 1. Number of active cardholders – 10,000
 - 2. Number of readers – 128
 - 3. Number of access groups – 255B

1.7 SOFTWARE

- A. The Access Control System Application Software (AS) proposed shall be proven to be robust and reliable prior to being supplied, installed, tested and commissioned. It shall be user friendly and flexible enough to provide interactive operator prompting to assist operator who are not familiar with the system terminologies, operating system or menu structures, to be able to operate the system with ease and minimal training.
- B. The Access Control System AS proposed shall provide English descriptions and messages using both text based menus and graphical icon displays. Other languages shall also be supported in the standard version. These are German, Dutch, Russian, Spanish, Portuguese (Brazil), Polish, Chinese (PRC).
- C. The Access Control System AS shall be capable to support to the following:
 - 1. Number of active cardholders – 10,000
 - 2. Number of readers – 128
 - 3. Number of access groups – 255
 - 4. Number of time schedules – 255
 - 5. 4 – 8 digits programmable (Personal Identification Number) PIN codes

6. Video channels – 128
7. Offline Locks – 128
8. Mapviewer floor plans – 128
9. Map links – 64 per map
10. Devices – 64 per map
11. Hierarchical levels between maps – 3
12. If these limits were reached, an upgrade to an Enterprise solution is possible without changing any of the installed hardware”.

D. Operator Rights

1. The software shall also allow the programming of individual operator’s permissions.
 - a. Permission regarding personal data shall be configurable to the following:
 - 1) Read only
 - 2) Read, write, change and delete
 - 3) Change the current location of persons
 - 4) change the access authorizations of persons.
 - b. Permission regarding event log messages shall be configurable to the following:
 - 1) view own messages
 - 2) view all messages without personal data view all messages
 - 3) Special permission for the configuration dialog.
 - 4) Special permission for door management.
 - 5) Permission regarding video application and devices shall be configurable to the following
 - 6) can use alarm verification
 - 7) can use video verification
 - 8) can use the specified group(s) of cameras
 - 9) can use live video
 - 10) can use the archive of video streams
 - 11) can record and export video streams

- E. The Access Control System AS shall provide a simple way for the system administrator to configure entrances selecting from a list of pre-defined door models. The following list of door models shall be provided by the system Door with entry and exit reader
 - 1. Door with entry reader and request to exit button
 - 2. Door with entry or exit reader
 - 3. Elevator with floor control
 - 4. Mantrap
 - 5. Door with combined arm/disarm IDS function
- F. Selecting a pre-defined door model shall automatically assign the corresponding reader.
- G. Cardholder Enrollment
 - 1. The Access Control System AS shall provide an easy way of entering cardholders into the database. In addition to basic data, such as first name, last name, badge number and access authorizations, the following information shall be possible, but not limited to:
 - a. 3 PIN codes (IDS, Access, Identification)
 - b. Validity period
 - c. Membership
 - d. Status fields, such as employee, visitor, guard
 - e. Address fields
 - f. Personal data
 - g. Individual fields editable by administrator
 - 2. Enrollment of electronic like cards, tags and fobs shall be possible through an access control reader connected to the LAC
- H. Cardholder Images:
 - 1. It shall be a standard feature provided in the Access Control System management software for taking photos, scanning or importing cardholder images into the cardholder database. Such that stored cardholder's image can be displayed automatically on the Access Control System workstation during access monitoring or for video verification purposes.
- I. Import and Export of Cardholder Master Records
 - 1. The Access Control System AS shall provide an import and export interface to import cardholder master records from a separate database during installation, or to export the master records for further use by another application.

2. The interface shall support at least commonly used comma-separated and fixed- field-length file formats for easy adaptation by applications when import or export.

J. Cards

1. A person can have up to three cards at a time. Every card has the same access authorizations and limits (validity limitations, locks, etc.).
2. Additionally the Identification PIN can be used like a card.

K. Access Authorizations:

1. Grouping of entrances that consist of one or more readers shall be possible, where one entrance can exist in several groups. A cardholder shall be assignable directly to any of the Access Authorization groups.

L. Area-Time Authorizations:

1. The Access Control System shall allow incorporating of access authorizations with time models. The assigned time model defines the time when an access authorization is active at an entrance or entrance group.

M. Time Models, Day Models, and Special Days:

1. The Access Control System AS provided shall allow the creation of time models for any specific day within the day models. Configuration for Special days, such as public holidays shall also be supported. The definition of time models provides a simple way of defining periodically recurring day models, which have a specific order. The time model can be used together with the access authorization at any entrance or entrance groups to control access.

N. Defining the Area of Control:

1. The Access Control System AS shall provide the ability for defining of logical areas, which could be single room, groups of rooms, entire floors where access control points/entrances could be assigned to.

O. Access Sequence Check

1. There shall be an access sequence check provided, allowing an authorized cardholder to enter a door or group of doors belonging to a pre-defined area only when he has already passed another dedicated door.

P. Dual or Multiple Authorized Access:

1. The Access Control System AS shall provide the possibility to configure and allow access to an access controlled door only when at least two authorized cardholders present their badges at the card reader. The number of cardholders for that kind of access check in front of an entrance should be limited by 6 persons.

Q. PIN Codes:

1. The Access Control System AS shall support the input of three kinds of PIN codes for each cardholder. The length of the PIN code (4 to 8 digits) is defined once in the system. The input of a validity period has to be supported.
 - a. Verification PIN – it will be requested after presentation of card at an entrance, as an additional security measure.
 - b. Identification PIN - This Identification-PIN can be typed at keyboard readers instead of presenting a card. As this PIN functions virtually as a card number it also carries with it all authorizations assigned to that card number.
 - c. Arming PIN - to arm the alarm system.
 - d. A fourth variety of PIN, the Door-PIN, can be assigned separately to individual doors. This code must be known to anyone using the door.

R. Duress Code Alarm:

1. A duress code alarm message shall be generated at the Access Control System and display on the monitoring workstation when cardholders keyed in their PIN codes in another defined way.

S. Blocking Cardholders:

1. The Access Control System AS shall allow the blocking of cardholders, for example by validity period.

T. Visitor Management:

1. Administration of visitors shall be provided by the Access Control System management software in the same database.
2. The visitor management shall allow the printing of a visitor badge from this data.
3. The following information should be assignable to a visitor:
 - a. Identification number
 - b. Access authorizations

1.8 MAPVIEWER

- A. The system shall contain a map viewer. This map viewer shall provide a graphical presentation of the premises or object by means of floor plans, object pictures or any desired graphical representation.
- B. Navigation links allow navigating from one map to the next. It should be possible to navigate maps horizontally on the same level enabling to cover a larger area with multiple maps next to each other, or vertically up to three levels in which navigation to the next map brings the underlying map e.g. navigate into the room details from the map showing the floor details.
- C. The map structure is given in a map tree at the left side of the active map. The tree allows jumping multiple layers or bypassing multiple correlated links by selecting the target map in the tree directly.

- D. Back and forward buttons in the top of the map viewer allow navigation between the maps by viewed sequence.
- E. On the maps entrances and cameras can be positioned as a graphical icon.
- F. These graphical icons will display the location of the device in the map and the actual status of the device. Clicking any of the devices automatically shows the controlling commands available for the respective device. Control commands are automatically linked based on device type.
- G. Access events at the door are automatically recorded by one or more future mapped cameras for a predefined recording time window. The time window for recording can be programmed.
- H. Future recordings will be part of the logged event and can be accessed by clicking on the camera symbol in the stored event line.

1.9 ALARM MANAGEMENT:

- A. The system shall offer alarm management. The alarm management builds on the map view functionality extended with an alarm list.
- B. The alarm list shall support multi handling ensuring when multiple operators are logged in at the same time the event can only be treated by one operator, the operator that treats the event first.
- C. In case of alarm the map with the alarm location will automatically get dialog focus and will be displayed accordingly. The device that triggered the alarm will show alarm status on the map by means of a .gif format animated icon to attract attention together with a beeping tone.
- D. The alarm shall appear in the alarm list dialog as alarm event. The alarms in the alarm list queue require a manual alarm acceptance from the operator.
- E. Alarm events in the alarm list require a written comment entry by the operator before it is possible for the alarm to be accepted. The comments are logged. Accepted alarms are removed from the alarm list.
- F. In case the operator navigates through maps while an unaccepted alarm exists, maps with a direct navigation link to the map with the alarming device, shall display any hyperlink to that map with an animated red blinking notification. This animated signalling navigation link indicates that behind this navigation link a map exists with an unaccepted alarm.
- G. The system shall offer alarm video verification as part of the alarm management.
- H. The alarm video verification builds on the alarm management functionality extended with video streaming and recording of alarm events.
- I. It shall be possible to map system devices on the map to one or more cameras for alarm video verification. If the respective device reaches the state of alarm the corresponding cameras will automatically start recording the event and show the camera live streams to the operator.
- J. Video Verification Access Capability:
 - 1. There shall be possibility by combining with future video devices to configure dedicated readers for video verification access mode.

2. Instead of opening the door immediately when an authorized card is presented, the reader/controller shall generate an event at the ACCESS CONTROL SYSTEM. A corresponding alarm dialog displays the stored image of the cardholder along with a live video image from the corresponding door. The operator shall determine if both images match, he can decide to open the door or to deny the access.
 3. It shall be possible to link up to 5 cameras per door to ensure video verification with optimal situational awareness at the door.
- K. Offline Locking System (OLS)
1. The Access Control System allows the integration of OLS devices.
 2. The personal data will be managed by the Access Control System Online System.
 3. Persons can use the cards they have for the Online System - but only the first one.
 4. There are special access authorizations regarding to the OLS.
 5. There are special time models regarding to the OLS.
 6. There are separate validation limits regarding to the OLS.
- L. Mantrap:
1. Mantrap function shall be provided to allow management of two or more interlocking doors controlled by two pairs or more of readers (in/out), or entrance readers and request to exit buttons. Only one door can open at a time. As long as one door is opened, the rest shall be blocked for access.
- M. Elevator Control:
1. The Access Control System AS provided shall allow the definition of floor access authorizations at designated lift, and assign them to card holders. If a cardholder presents his card at the elevator reader, the system shall activate the elevator floor buttons the cardholder has authorized access.
- N. Random Screening:
- O. The Access Control System AS shall be able to perform an additional security check by the officer on duty at the site/building exits. The readers at such exits are easily set to that mode by checking a checkbox and setting the frequency. At Random, the selected door should not opened, but an event shall be triggered at the Access Control System monitoring workstation. Upon receiving the message, shall remind the operator/guard to check the cardholder and his pockets/bags. After which, he can decide to open the door manually by clicking on the door icon inside the location map, release the card reading with a special configured reader, or delete the locking via dialog.
- P. Time and Attendance Data:
1. Access control readers shall be allowed to be configured additional as time and attendance readers. The booking events are stored in a separate file to export them for use in other applications.

Q. Access Control Management Alarms and Events

1. The Access Control System AS shall provide a wide range of standard alarm and event states. The following alarms/events, but not limited to, shall be supported:
 - a. Card unknown
 - b. Card not authorized
 - c. Card outside time profile
 - d. Card anti-passback
 - e. Access timeout
 - f. Door open time exceeded
 - g. Door opened unauthorized
 - h. Door blocked
 - i. Tamper alarm controller
 - j. Tamper alarm reader
 - k. PIN code error
 - l. Duress alarm code
 - m. Access denied
 - n. Wrong card version
 - o. Card blocked
 - p. Card blacklisted
 - q. Card out route
 - r. Random screening
 - s. Other individual alarm extensions
- R. All alarm/events have to be logged in the central Access Control System event log files together with all assigned alarm documents for a complete reporting.
- S. The Access Control System AS provided shall have support for central alarm monitoring and management. It shall provide a graphical user interface (GUI).
- T. The Access Control System AS shall provide practicable the central configuration platform or tool from where everything concerning system behavior, such as access control cardholder settings, display features, and authorizations are set up.

- U. The Access Control System AS shall securely logged all events, alarm activations and operator's actions/responses into the alarm/event log files, so to prevent after-the-fact changes, and to protect data from any manipulation.
- V. The events log files shall include an advanced filter functions such that archive can be kept small and precise. If required, only desired information shall be archived.
- W. A device tree and the device names shall be provided for in the GUI.
- X. The Access Control System AS shall support any standard laser or inkjet printer that comes with a Windows-compliant printer driver for use as an alarm printer. The printers shall be connectable directly to a workstation or to the network.

1.10 GRAPHICAL USER INTERFACE

- A. The Access Control System GUI shall support single or multi screen displays having multiple dialogs separately over a maximum of two(2) monitors per workstation by using a corresponding video graphics card.
- B. The Access Control System shall provide a default GUI that is adequate and ready for used in normal system operation. It shall support at least the following standard resolutions: 1024x768, 1280x1024 (1-monitor operation), 2048x768 and 2560x1024 (2-monitor operation).
- C. The Access Control System GUI shall enable operators to find a specific detector, door, or reader for fast control, such as open door manually, show camera live image, and so on.
- D. In the event of alarm activation, the alarm message shall be displayed at the destined Access Control System operator workstation together with an external audible siren or via PC internal speaker.
- E. For the alarm sound generated from the PC internal speaker, standard formats such as WAV, MP3 or WMA shall be supported and selectable for assigning to individual alarm/event or groups of alarms/events during system configuration.

1.11 ACCESS CONTROL SYSTEM ALARM HANDLING AND MANAGEMENT

- A. The Access Control System shall provide the operator a simple and efficient way to handle any incoming alarms.
- B. Only authorized operator with the valid login username and password shall be able to access and operate the system. Once successfully login, the operator shall only see all the alarm and event messages destined to him for monitoring and processing based on his user login access profile.
- C. The operator shall be able at the Access Control System workstation acknowledge/accept, response to incoming alarm or event messages. The location of the alarm shall be displayed by animation on a graphical representation of the premises.
- D. All incoming alarms at the Access Control System GUI workstation shall contain a comprehensive alarm message.
- E. The incoming alarm or event message shall provide, but not limited to, the following information:

1. Alarm date and time
 2. Alarm status
 3. Current alarm condition
 4. Alarm location
- F. The operator shall be able to silence the audible alarm sound or buzzer, while he is busy processing earlier alarms.
- G. The alarm message shall also show live video images from the Video Verification camera installed at the alarm location such that, the operator can have first time view of the site situation if required.
- H. The operator shall be allowed to revert or toggle between all alarms or events messages.
- I. The Access Control System operator shall also be able to send remote commands or activate controls manually from the workstation when requested such as, unlocking and re-locking of access controlled door/s, or resetting of detectors.
- J. The operator shall be allowed based on his login access profile generate alarm and event reports from his operating workstation.

1.12 ACCESS CONTROL HARDWARE

- A. The Access Control Hardware provided shall conform, but not limited to the following requirements and directives:
1. CE
 2. EN 50130-4:1995
 3. EN 61000-3-2
 4. EN 61000-4-2
 5. EN 61000-4-4
 6. EN 61000-4-6
 7. EN 55022:1998
 8. EN 60950:2000
 9. EN 61000-3-3
 10. EN 61000-4-3
 11. EN 61000-4-5
 12. EN 61000-4-11
 13. EN 50131-1

14. C-Tick

- B. The Access Control Hardware provided shall be of modular design with a download software built-in so that the application program can be easily changed and downloaded without the physically touching the controller itself.
- C. The Access Control Hardware design shall be of standard 19" rack mountable and also rail mountable for installation in an weather-proofed enclosure suitable for used in outdoor.
- D. The connection from the Access Control Hardware to the Access Control System server running the management software shall preferably by Ethernet 100BaseT or RS-485.
- E. The Access Control Hardware shall have a 16-characters liquid crystal display (LCD), and a button provided for selecting the display to show all its network parameters and actual status like:
 - 1. IP address of the controller
 - 2. MAC address of the controller
 - 3. DHCP on/off
 - 4. Status of all the inputs connected to it
 - 5. Status of all the outputs connected to it
 - 6. Online and Offline status of the controller
 - 7. Firmware version
 - 8. Date and Time:
 - 9. A real time clock (RTC) that will adjust itself to leap year computations automatically.
- F. The Access Control Hardware shall support and include a standard Compact flash (CF) memory card for storing cardholder data and access events. The CF memory card must be formatted with a standard FAT file system, to allow reading them using a standard card reader connected to a computer, if the Access Control Hardware fails.
- G. The Access Control Hardware memory shall under no circumstance loose a single, not even the last transaction when power fails.
- H. The Access Control Hardware and all devices connected to it shall continue to operate and control access in off-line mode, even if the computer network fails.
- I. The Access Control Hardware memory shall store database that has a capacity with a minimum of 80,000 cardholders (upgradeable to 400,000), each having a programmable 4 – 8 digits (Personal Identification Number) PIN codes
- J. The cardholder database shall be upgradeable by exchanging the CF card. The system shall automatically detect the size of the CF-card.

- K. The Access Control Hardware provided shall support the connectivity of up to maximum of 4 standard Wiegand interface readers or 8 serial interface readers operating on RS485 bus technology.
- L. The Access Control Hardware provided shall support multiple, but not limited to the following card formats:
 - 1. Wiegand 26 Bit
 - 2. Wiegand 35 Bit (HID Corporate 1000)
 - 3. Wiegand 37 Bit (HID iClass)
 - 4. Mifare 32 Bit CSN
- M. The Access Control Hardware shall provide minimum eight programmable I/Os on board, and shall be expandable to 32 each, using I/O extensions.
- N. All inputs provided shall be configurable to provide 2- or 4- status selectable, via End-Of-Line (EOL) resistors, namely:
 - 1. Input Closed
 - 2. Input Opened
 - 3. Input Shorted (provided in 4- status mode)
 - 4. Input Tamper (Cable cut, provided in 4- status mode)
- O. EOL resistor's values shall be flexibly selectable in the Access Control System management software during configuration.
- P. The Access Control Hardware and all devices connected to it shall continue to operate and control access in off-line mode, if there is a failure with the computer network.
- Q. The Access Control Hardware shall support standard CF flash memory card for storing cardholder data and access events. The CF memory card must be formatted with a standard FAT file system, to allow reading them using a standard card reader connected to a computer, if the Access Control Hardware fails.
- R. The Access Control Hardware Firmware is updateable through the Host System via download
- S. The Access Control Hardware memory shall under no circumstance lose a single, not even the last transaction when power fails.
- T. UPS shall be provided to continually supply power to the Access Control
- U. Hardware and readers for a minimum of 2-hours, in the event of power failure.
- V. The Access Control Hardware shall generate a transaction record and save them in its memory for every alarm, they include –
 - 1. Time/date of occurrence and restoration

2. Location of alarm sensors

1.13 SPECIFICATIONS FOR PROXIMITY CARD READER

- A. The proximity card reader provided shall be of ruggedized design, sealed in weatherized polycarbonate enclosure to withstand harsh environments for both indoor/outdoor used and provide a high degree of vandal resistance.
- B. Power requirement: 10 – 16Vdc.
- C. Transmit frequency: 125 kHz
- D. The proximity card readers shall have a read range of at least 3”.
- E. The response time to unlock the door after a card is presented to the card reader shall not exceed 1.0 second +/- 0.5 second.
- F. The card reader unit shall have an integral keypad with beeper, multi-color LEDs.
- G. The keypad shall have back-light to allow easy viewing, in case of power blackout. It shall lights automatically upon pressing any key or when a card is presented to the reader.
- H. The overall thickness of the card reader unit shall not exceed 30 mm.

1.14 SPECIFICATIONS FOR CONTACTLESS SMART CARD READER

- A. The Smart card reader provided shall be of ruggedized design, sealed in weatherized polycarbonate enclosure to withstand harsh environments for both indoor/outdoor used and provide a high degree of vandal resistance.
- B. The smart card reader shall be based on contactless smart card 13.56MHz technology for connection to the Access Control Hardware with Wiegand interface.
- C. The contactless smart card reader provided shall be capable of reading MIFARE serial number in 32-bit format in accordance with ISO standard 14443A.
- D. The data transfer between the contactless smart card reader and smart card shall be encrypted.
- E. Power requirement: 10 – 16Vdc.
- F. The contactless smart card readers shall have a read range of at least 2.4”.
- G. The response time to unlock the door after a card is presented to the card reader shall not exceed 1.0 second +/- 0.5 second.
- H. The card reader unit shall have an integral keypad with beeper, multi-color LEDs.
- I. The keypad shall have back-light to allow easy viewing, in case of power blackout. It shall lights automatically upon pressing any key or when a card is presented to the reader.
- J. The overall thickness of the card reader unit shall not exceed 30 mm.

1.15 SPECIFICATIONS FOR PROXIMITY CARD

- A. The offered proximity cards shall be similar in size and thickness as standard credit cards or bank ATM cards.
- B. The proximity cards shall operate on 125 kHz.
- C. CE/UL Approvals

1.16 SPECIFICATIONS FOR CONTACTLESS SMART CARD

- A. The offered contactless smart cards shall be similar in size and thickness as standard credit cards or bank ATM cards.
- B. The offered smart cards shall be of contactless technology operating on 13.56
- C. MHz and shall be compliance to ISO standard 14443A.
- D. CE/UL Approvals

1.17 SPECIFICATIONS FOR FINGER-PRINT (FP) BIOMETRIC READER & OPERATIONS

- A. The Finger-print (FP) biometric reader provided shall be of ruggedized design, having weatherized polycarbonate enclosure or similar protection to withstand harsh environments for both indoor/outdoor used and provides a high degree of vandal resistance.
- B. The FP biometric reader shall provide two-factor authentication with the combination of a proximity [/contactless smart] card and a fingerprint biometrics.
- C. The FP biometric reader together with the proximity card shall support operation with 1:1 verification mode or 1:N, identification mode.
- D. The FP biometric reader shall continue to operate to control access in off-line mode. When the network connection restored, the reader shall automatically upload and synchronize its database with the server.
- E. The FP biometric reader shall include a FP scanner that uses capacitive verification techniques for the live finger recognition and resistance of the human skin.
- F. The FP biometric reader provided shall have a read tolerance of at least +/-30 degree and a displacement of about +/- 5mm from the FP scanner.
- G. The same FP biometric reader provided shall be able to be used for both access control and as an enrollment station.
- H. The specifier shall supply and install the necessary software to manage the FP enrollment for all users and configuration of the FP access control operations. The software provided shall be integrated to the Access Control System for access control and monitoring.
- I. During enrollment process, the FP biometric reader and software used for capturing the finger-print shall provide, but not limited to the following:
- J. The FP image shall have a minimum size of 256 x 360 pixels
- K. Provide full visibility of the ridge details including texture, continuity, edges and pores.

- L. Allow for real-time on-screen preview of the FP image while performing the FP capture.
- M. FP captured shall have resolution of at least 500dpi.
- N. Minutiae file size of at least 256 bytes.
- O. The FP enrollment process shall support a percentage estimation of the image quality such that the operator can accept or reject the enrolled FP.
- P. Up to a maximum of 10 FP templates shall be allowed to be assigned to a single user.
- Q. The enrolled FP templates shall be stored in the Access Control System centralized database as well as within the reader's memory storage.
- R. The FP templates stored shall incorporate a date stamp and shall record the number and/or name of the finger taken.
- S. The FP images captured shall be stored in an open format such as jpeg or bmp for the purpose to export for further use by another application when required.

PART 2 (Not Used)

PART 3 (Not Used)

END OF SECTION 281300

SECTION 282300 – VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cameras.
- B. Control equipment.
- C. Cable and accessories.

1.2 RELATED SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- B. Section 28 05 00 - Common Work Results for Electronic Safety and Security
- C. Section 28 05 26 - Grounding and Bonding for Electronic Safety and Security.
- D. Section 28 05 28 - Pathways for Electronic Safety and Security.
- E. Section 28 05 53 - Identification for Electronic Safety and Security.
- F. Section 28 06 00 - Testing for Electronic Safety and Security.
- G. Section 28 13 00 – Access Control.
- H. Conduit, cable tray and back boxes for this system shall be furnished and installed by the electrical contractor under the supervision of the security contractor.
- I. See Division 26 for all information relating to the fire alarm system and required relay interface to release emergency delay exit doors. The fire alarm integrator shall provide the control relays as required.
 - 1. See Division 26 for all specifications governing the performance of work associated with the installation of raceway, system junction and pull boxes and device rough-in boxes for all work shown in the Access Control System refer to the SC series security drawings.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005
- B. EIA/TIA-569 Standard, Commercial Building Standard for Telecommunications Pathways and Spaces
- C. EIA/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
- D. National Electrical Code (NEC) (Latest revision and pertinent addendums)
- E. National Fire Protection Association (NFPA) Publications (Latest revisions and pertinent addendums)

- F. Americans with Disabilities Act (ADA)
- G. NFPA 101, National Fire Protection Association
- H. UL 294, Underwriter's Laboratories Access Control Systems
- I. UL 1037, Underwriter's Laboratories Anti-Theft Alarms and Devices
- J. UL 1076, Underwriter's Laboratories Propriety Burglar Alarms Units and Systems
- K. EIA-RS-170 Broadcast Standards
- L. NTSC Color System Standards
- M. Building Officials and Code Administrators International, Inc. (BOCA) National Building Code
- N. Uniform Building Code (UBC)
- O. Local Governing Authorities Having Jurisdiction

1.4 CONTRACT DOCUMENTS

- A. All work of this Section shall comply with the requirements of the Conditions of Contract (including: Bidding requirements, Contract forms, Conditions of Contract and Standard forms), with all Specification Sections of Division 1 General Requirements, with the Drawings, and with all other Contractual Documents.
- B. Coordinate with other Division sections as required.

1.5 SYSTEM DESCRIPTION

- A. This Section specifies the requirements for the Video Surveillance system.
- B. Scope of Work
 - 1. The work detailed by these specifications and drawings has been specified to meet certain requirements for performance. Some information, such as exact equipment layout, wire routing, additional conduit and power requirements, etc. has been omitted. It shall be the responsibility of the Contractor to translate these specifications and drawings into a complete design package containing all necessary elements for a complete turnkey installation including all material, labor, warranties, shipping and permits.
 - 2. Work shall include the installation and commissioning of the following:
 - a. Video Surveillance System (VSS)
 - 3. Work to include, but not limited to the following:
 - a. Perform camera pre-installation sign-off walk through with Owner and Security Consultant.
 - b. Installation of cameras and camera cabling
 - c. Provide all required software and licenses to the Owner.

- d. Contractor shall provide continuous on-site supervision of the installation technicians. On-site supervision shall include: daily supervision of the work, updating work site progress drawings to reflect changes and installations details, preparing weekly progress reports and attendance at site coordination meetings as directed by the Owner and Security Consultant.
 - e. The Contractor shall provide continuous engineering and programming support during the installation as required to accommodate existing conditions and unforeseen conditions that may arise during performance of the work.
 - f. The Contractor shall provide all miscellaneous hardware including cable management devices, termination cabinets, wire and cable labeling materials, fasteners, hangers and brackets as required.
 - g. The contractor will coordinate the delivery and storage of all materials, wire, cable, equipment and miscellaneous hardware.
4. Description: Provide video communications between points of surveillance indicated on Drawings and central monitoring station.
 5. The contractor shall provide all materials, equipment, labor and all other incidental material, tools, appliances and transportation as required for a complete and functional video surveillance system (VSS) as described herein and supplementary drawings.
 6. General elements of the work shall consist of but not limited to:
 - a. Procure all permits and license required to complete this installation.
 - b. Submission of Schedule of Values for all equipment, materials and labor.
 - c. Attend pre-construction/pre-submittal meeting with Campus Safety Systems Manager and Security Consultant to review design package for security and finish hardware.
 - d. Submittal preparation and processing prior to ordering equipment.
 - e. Attend finish hardware submittal review meeting.
 - f. Coordination of conduit system, raceway and power distribution provided by Division 26 contractors.
 - g. Coordination with all trades and Owner representatives as required facilitating the installation of the security equipment including: Door Hardware, Fire Alarm and Electrical Divisions.
 - h. Provide security system sensors, cable, connectors, wiring, equipment enclosures and all other materials necessary to complete the security system per the design documents.
 - i. Verify conditions and dimensions at the job site prior to installation.
 - j. Coordinate all system programming and camera naming with UIT.
 - k. Perform pre-installation camera position and view sign off with Campus Safety Systems Manager.

- l. Perform installation according to contract documents and manufacturers recommendations.
- m. Protect new facilities finishes and equipment.
- n. Maintain construction materials and refuse within the area of work.
- o. Clean the work area at the end of each day.
- p. Perform initial testing and adjustments with written reports.
- q. Make final adjustments and calibrations as directed by the Campus Safety Systems Manager
- r. Demonstrate all systems and component operations for final acceptance.
- s. Preparation of O&M manuals and as-built documents for Campus Safety Systems Manager's use.
- u. Provide warranty service for a period of one year from acceptance date.

1.6 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements, including system wiring diagram.
- C. Standards Section 12.0.2.1 "Camera Model Specifications and Use Requirements" provide a schedule demonstrating that the selected camera and lens at each camera location meets the required use criteria. Schedule shall include all PPF and lens calculations.
- D. Product Data: Provide showing electrical characteristics and connection requirements for each component.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Project Record Documents: Record actual locations of cameras and routing of television cable.
- G. Operation Data: Instructions for starting and operating system.
- H. Maintenance Data: Routine trouble shooting procedures.
- I. The submittal shall be a detailed response describing methods, procedures and specific equipment proposed to conform to the system design detailed in these documents.
- J. Submittals shall consist of product data, shop drawings, samples and detailed completion schedules.
- K. Partial submittals shall not be accepted without prior approval by Owner. No portion of the work shall commence or equipment ordered until the Owner has approved the submittals.

- L. The Contractor shall not be relieved from any contract-required responsibility by the Owner's approval of submittals.
- M. Nothing in the specification shall relieve the Security Contractor of responsibility in delivering a functioning turnkey security system.

1.7 SUBMITTAL REQUIREMENTS

A. Product Data

1. Provide Submittals no less than 10 working days after notice to proceed.
2. Submit data in 3-ring binder divided into separate section (Access Control, Video Surveillance, etc.) for each system.
3. Equipment lists and equipment data sheets shall be 8.5" x 11" in size.
4. Each section to include the following:
 - a. List all system components with an assigned item number, manufacturer, model number and quantities of each.
 - b. Manufacturer's literature sheets for all materials and equipment, including warranty information and recommended preventative maintenance and spare part inventory recommendations. Literature containing more than one device shall be clearly marked to delineate item(s) included in the work.
 - c. Clearly indicate color or special finishes.
 - d. Cable types including manufacturer's verification and acceptance information.
 - e. General functional description of each system including:
 - 1) Description of operating systems and application software.
 - 2) Power requirements and UPS sizing.
5. Schedule of Values
 - a. Contractor shall submit in addition to Division 1 requirements, a Schedule of Values, which includes itemized listing of all equipment, materials and labor required for the installation of the VSS as specified herein for Change Order pricing. Listing shall contain: assign item number, item description, item model number, item quantity, unit cost and extended labor, material and installation cost to provide a complete and functional security system. Submit in electronic format (Microsoft Excel).
6. Shop Drawings
 - a. Provide Shop Drawings no less than 25 working days after notice to proceed.
 - b. Reproducing Contract Documents for shop drawing is not acceptable.
 - c. Submit 3 complete sets of shop drawings along with CD-ROM copy to the Security Consultant.

- d. Produce all shop drawings on latest version of AutoCAD.
 - e. Shop drawings to include the following:
 - 1) Drawing legend sheet describing all symbols used on the drawings.
 - 2) Floor plans with all device locations and wiring.
 - 3) Wire runs to include tags for type, gauge, quantities and cable identifiers.
 - 4) System riser diagram indicating all field devices, riser paths and room designations.
 - 5) Block diagram for each system showing: all equipment, interconnections, network connections and data flow.
 - 6) Point schedule-defining interconnection of all inputs and outputs for all equipment including fire alarm interface, data connections and other systems.
 - 7) Schedule of device power requirements, power source and load calculations.
 - 8) Elevations of equipment racks with new equipment.
 - 9) Elevations of electrical closet(s) with security DGP panel, termination enclosure, wire management, lock power supply(s), UPS, and power routing, etc.
 - 10) Fabrication shop drawings for all custom equipment.
7. Samples
- a. Upon specific request of the Owner and Security Consultant, submit samples of any proposed devices.
8. Resubmitting
- a. Make corrections or changes in Submittals as required by the Security Consultant's stamped instructions and attached comments and resubmit.
 - b. Identify changes on resubmittals by clouding. Only indicated changes will be reviewed when resubmitted.
 - c. Added drawings shall be clearly identified.
 - d. Contractor shall be responsible for project delays caused by rejected submittals.
 - e. Security Consultant shall be compensated for additional services for submittals rejected more than twice. The amount of such compensation shall be incorporated by change order and withheld from the Contractor's Application for Payment.

1.8 RECORD DOCUMENTATION

- A. Furnish 3 complete sets of record documents.
- B. Record documents shall include all revised information provided as submittals and reflect as

installed revisions.

C. General Description and Requirements

1. Record drawings shall consist of As-Built Drawings and Operation and Maintenance Manuals.
2. Transmit 3 copies of a preliminary draft of the Record Documents to the Owner and Security Consultant prior to final acceptance testing and training.
3. Update all Record Documents to reflect changes or modifications made during final acceptance testing as required.
4. Submit 3 sets of final corrected Record Documents to the Security Consultant within 30 days from the date of final acceptance.
5. As-Built Drawings
 - a. Furnish 3 complete sets of as-built drawings along with a complete CD-ROM copy.
 - b. Maintain on the job site, current up to date as-built drawings and schedule(s) including most recent changes. Included field notes shall be neat and legible. The Contractor shall make any needed changes to this drawing and schedule set as to accurately depict the as-built condition of the security system as it is installed.
 - c. As-built Drawings shall, at a minimum, include the following:
 - 1) Floor plan drawings (1/8"=1' scale) indicating device location, with device legends indicating manufacturer and model number for each device.
 - 2) Floor plan drawings (1/8"=1' scale) indicating wire routing or approximate routing for existing wiring. Wiring shall be tagged with cable identifier and terminal strip number, which references wiring schedules.
 - 3) Mounting details for all equipment and hardware.
 - 4) Functional block diagrams for each system and subsystem.
 - 5) Wiring details showing: rack elevations, DGP and support equipment elevations, equipment wiring and terminations and inter-rack wiring.
 - 6) Typical point-to-point wiring for each piece of equipment and groups of equipment within the system.
 - 7) Schedule of all devices with associated panel termination, zoning, power circuit numbers, etc.
6. Operational and Maintenance (O&M) Manuals
 - a. Provide 3 complete operation and maintenance manuals for all equipment and devices with project title and contractor's name on cover and spine.
 - b. Submit operation and maintenance manuals in 3 ring binders.

- c. O&M manuals shall include:
- 1) Provide table of contents page with tabbed divider sections for each device or system.
 - 2) Tabbed sections shall include: theory of operation, design philosophy, specific functions and system block diagram.
 - 3) List of manufacturer's, their local representatives and subcontractors that performed work on the project. List to include contact names, addresses and phone numbers for each.
 - 4) Custom written instructions and procedures for system operation.
 - 5) Operator commands.
 - 6) Start-up and shutdown procedures.
 - 7) Detailed programming descriptions for each system.
 - 8) Manufacturer's operation manual for each piece of equipment in the system. Product data sheets are not acceptable.
 - 9) Custom written quick users guide for inexperienced operators.
 - 10) System backup disk.
 - 11) System software licenses.
 - 12) Equipment list, including a brief description, model, and the total number of each item used in the project.
 - 13) A separate list of serial numbers for all items used in the system
 - 14) Copies of all programming specific to the job, including new code, initial parameters, and settings entered on site, etc.
 - 15) Setup procedures for each component in the system.
 - 16) Maintenance requirements for equipment, inspections and preventative maintenance schedules.
 - 17) Final test data (measured levels and other significant operating parameters).
 - 18) List of system associated mechanical locking keys and tamper resistant hardware types with key codes.

1.9 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

- C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- D. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of Project.
- E. Products: Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.
- F. Contractor Qualifications
 - 1. An experienced Contractor shall perform the installation. Contractor shall have at least 5 years' experience in the installation of security systems of similar size and scope.
 - 2. The installation shall be performed by a Contractor licensed by the Texas Board of Private Investigators and Private Security Agencies and shall be bonded and insured.
 - 3. All installation personnel shall also be licensed as required by local and/or state jurisdictions.
 - 4. Contractor shall provide all licensing documentation as part of the bid.
 - 5. Owner's representative may make such investigations as deemed necessary to determine that the Contractor is responsive, responsible and qualified in the area of work contemplated by the contract. In this regard, the security system installation firm shall furnish to the Owner such information and data as shall be requested for this purpose. Information and data may include (but not necessarily be limited to): Date of organization and/or incorporation and number of years engaged in this business under present firm's names; list of major equipment owned by the company; list of principal personnel who will be involved in the execution of this contract with the experience and qualifications of each person.
 - 6. The Contractor shall provide a project manager that shall be constantly in charge of the VSS installation. The project manager shall be the same person authorized to make decisions and answer questions asked by the Architect and Owner Representatives. The project manager shall also be responsible for system programming, preparation of Operation and Maintenance Manuals, Training, Programs, Schedules and Test Protocols, documentation of system testing, maintenance of Record Drawings and coordination and scheduling of all labor.
 - 7. Provide evidence of site supervisor's qualifications and work history
 - 8. Contractor shall be or have direct relations through their subcontractors, and authorized manufacturer's representatives for all products they furnish or install.
 - 9. Provide documentation that the Contractor and or subcontractor are factory certified to install, program, train and repair all major components or systems to be used in the project.
 - 10. Contractor shall have a local organization capable of providing maintenance and service for the specified system. Facility shall be no more than 100 miles from Owner's site. The security system installation firm shall be capable of providing emergency service on a 24-hour, 7 days a week basis.

1.10 PRODUCT STANDARDS

- A. The Contractor will provide all materials, equipment and installation in compliance with the latest applicable standards from ANSI, FCC, ASTM, EIA/TIA, IEEE, NEC, NFPA, NEMA, REA and UL including but not limited to:
1. EIA/TIA-569 Standard, Commercial Building Standard for Telecommunications Pathways and Spaces.
 2. EIA/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 3. ANSI T1.404 (DS3) and CATV Applications
 4. National Electrical Code (NEC) (Latest revision and pertinent addendums)
 5. National Fire Protection Association (NFPA) Publications (Latest revisions and pertinent addendums)
 6. Americans with Disabilities Act (ADA).
 7. In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify in writing to Engineer of any such occurrences before the purchase of any equipment, materials and/or installation by the Contractor. The Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.
 8. All equipment, materials and articles incorporated in the work covered by this contract are to be new and unused.
 9. The contractor shall provide at installation time the latest current standard model and/or version of all equipment (hardware and software).

1.11 MAINTENANCE SERVICE

- A. Furnish service and maintenance of surveillance system for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 COMPONENTS

- A. Models:

Camera / NVR Type	Manufacturer/Product Lines	Application
Facial ID	Pelco Sarix Enhanced IME+ Next Generation with SureVision 3.0	<p>Ingress doors, gates and traffic areas with lane control. The specific model will accommodate a 100 pixels per foot requirement at the point of interest.</p> <p>May also be used in areas with marginal lighting conditions.</p>
Activity Detection	Pelco Sarix Enhanced IME series with SureVision 2.0	<p>Detection and overviews with a 20 ppf requirement at the far end of the view.</p> <p>To be deployed in the following areas:</p> <ul style="list-style-type: none"> Hallways Lobbies Elevator landings Stair landings Exterior card readers Plazas Parking lots <p>MODEL SELECTION:</p> <p>Specific models are based on business use requirements as determined by the business owner</p> <p>The University of Houston Department of Campus Safety Systems will approve the most appropriate model. The model selection process is based on the following criteria:</p> <ul style="list-style-type: none"> PPF — Pixels per foot Lighting conditions Environmental Variables Analytics requirements Network Impact <p>*** Consult Campus Safety for final model approval.</p>

Alternate Indoor Low Light Facial ID or Activity Detection	IXE series with SuerVision 3.0	Indoor applications facial ID / Activity Detection
Alternate form factor Indoor / Outdoor	IBE series with SureVision 3.0	Facial ID or Activity Detection indoor, outdoor
Panoramic IP	Pelco Optera 180 Series	Building perimeters Parking lots Large indoor arenas Irregular hallways Athletic facilities,
PTZ	Pelco Spectra IP (20x or 30X zoom)	Live Event Monitoring indoors or outdoors.
Specialty Camera License Plate Readers	AXIS Q1765LE 2 MP with built-in IR arrays	License Plate Readers; Confined areas with lane control under varying light conditions. ***Consult with the Campus Safety Systems Manager for final design approval
Video Server	Pelco DSSRV2	Pelco DSSRV2 -Digital Sentry NVR Firmware version must up to the latest version at the time of system installation. ***Consult with the Campus Safety Systems Manager for final design approval

- B. PoE Switches. OFOI
- C. NVR licenses required for proper surveillance camera operation.
- D. Configuration Requirements.

CAMERA – Pelco Fixed		
Firmware	Must up to the latest iteration at time of installation	
Frame rate per second	Activity Detection - 5	Facial ID - 10
Shutter speed (max exposure time)	10 ms	
Maximum Gain	30 percent	
WDR setting	50 percent when backlit	
NVR Recording quality	80 %	

NVR Recording Resolution	Full	
Aspect Ratio	4:3 for non-panoramic	
Motion Record (MR)		
MR sensitivity	default	
MR motion area	default	
MR Reference Count	120	
MR consec. frames for record	3	
MR consec. frames to stop record	50	
Scheduled recording	Motion 24/7 max resolution	
Motion record source	In Camera	
Onscreen Labeling	Room name and/or number or object viewed (must match cam schedule and schematics)	
Network cable and device labeling	Refer to Network Cable Infrastructure Standards http://www.uh.edu/infotech/services/computing/networks/network-infrastructure-standards/index.php	
Login Credentials	Default (do not change)	
CAMERA – Pelco Optera		
Aspect Ratio	Panoramic default	
All other parameters	Same as Pelco fixed	
CAMERA – Axis LPR		
Shutter Speed	1/1000	
NVR – DSSRV2		
NTP server address	ns1.uh.edu America/Chicago	
DNS	Primary 172.21.12.17 Secondary 172.21.12.1	
Login Credentials	Default	
Remote Desktop	Enabled	
Ping	Enabled via Firewall (ICMP)	

2.2 GENERAL

- A. Manufacturer's name and product lines are given in the specifications for the purpose of establishing a standard of performance, quality, style and compatibility with the existing network and surveillance video infrastructure.
- B. These specifications list approved equipment types and items. In instances where quantities are not detailed, they shall be obtained from the drawings.
- C. Alternatives will only be considered if a unique business requirement cannot be met by approved product line, and if specified features are fully supported by the existing

infrastructure.

2.3 Video Surveillance System

- A. System Description: Provide and install an IP Video Surveillance system including IP cameras, data cabling per division 27, mounts, domes, dedicated security patch panels and any required components/accessories.
- B. General
 - 1. Cameras and support wiring to the common equipment location and video processing equipment in the MDF.
 - 2. Common equipment location with mounting board, support equipment, wire management and power.
- C. Video Cameras
 - 1. Camera schedule location, camera view, lens and mounting method are for reference purposes. Contractor is responsible for coordinating these details with Campus Safety Systems Manager and Security Consultant.
 - 2. Contractor is responsible for lens calculation prior to installation of cameras; specify fields of view rather and exact position of cameras.
 - 3. Prior to camera installation, contractor will verify lens placement to optimize view. Refine for local focus and viewing during installation. Final camera position and lens schedule shall be submitted for Security Consultant's approval.
- D. Camera Signal Transient/Surge Protection
 - 1. Provide camera transient/surge protection as specified in the drawings and specifications.
 - 2. Protector to guard sensitive electronics against lightning induced surges, electrostatic discharge and ground loop energies.
 - 3. Install at video head end and at all exterior cameras
 - 4. Connect to nearest communication ground bus or proper building ground.
- E. Video Camera Power Supply(s)
 - 1. Cameras will be PoE. PoE switches will be OFOI.

2.4 STATIC CAMERA SYSTEM

- A. Camera resolutions will be determined by the desired Pixels per Foot to achieve the required level of detail at a specified distance from the area of interest in order to meet a specific application. Applications include: Activity Detection; License Plate Reading; and Facial Identification.
- B. Inherent camera characteristics such as lux ratings, dynamic range; anti-bloom capabilities; and auto black and white mode are solely dependent on the location and environmental

conditions of a given deployment.

- C. Provide ground isolation transformers as required to eliminate hum bars and ground loops.
 - 1. Pelco IDE20DN-PMO
 - 2. or UH IT approved equal.
- D. For outdoor installations, provide adequate surge protection measures to include the following:
 - 1. Float cameras in their housings by using nylon washers.
 - 2. Ground camera casings utilizing building ground.
 - 3. Provide adequate network equipment protection by installing POE circuit protection such as DTK-MRJPOE or approved equal.
- E. NVR-DVR recording resolutions must meet pixel per foot camera requirements.
- F. NVRs must have a Gigabit uplink on the building's network distribution switch.
- G. PoE switch port utilization must not exceed a maximum of 22 cameras per switch and less if other devices are drawing power from this switch. 15.4 watts per port is the minimum requirement. Consult with the Network Operations group for PoE switch requirements.

2.6 CAMERA VIDEO AND POWER TRANSIENT/SURGEVPROTECTION DEVICE

- A. Provide inline camera video signal and power protection at all outdoor camera locations with grounds connected to closest electrical ground as specified in the drawings and specifications

2.7 CAMERA POWER SUPPLY

- A. Camera power to be provided by Power over Ethernet (PoE). Adjunct power may be required for enhanced PTZ applications.

2.8 WIRE AND CABLE

- A. Category 6 per Division 27 specifications

2.9 ACCESSORIES

- A. Rack: Provide free-standing equipment Rack.
 - 1. Size: 7' x 19" with minimum 6" vertical cable managers on each side.

PART 3 EXECUTION

3.1 INSTALLATION

- A. This section covers the general requirements for the installation of the security system by the Contractor.

- B. Install in accordance with manufacturer's instructions.
- C. The Contractor shall be responsible for providing all wire and cable as required for complete and operational system.
- D. All cables must be continuous runs from device location to the final point of termination. No mid run cable splices will be allowed.
- E. The cable installation techniques shall be such that the mechanical and communications characteristics of the cables are not degraded at the time of installation. Any special environmental requirements for equipment shall be specified.
- F. Distribution of the cabling will be accomplished through cable trays, cable runways, conduit raceways, ducts, core holes, extended columns, false half columns and plenums. Cabling shall be run at right angles. Horizontal cable segments will be placed in cable trays and when they leave cable trays will be supported by distribution rings or J-hooks. Where cables converge at equipment room locations, they will be supported by cable runways and distribution rings. All cable placements shall be based on the enclosed drawings.
- G. The contractor shall not place security wiring in the same conduit or raceway with wire for electrical power distribution.
- H. Connectors to all devices in system shall be protected against moisture. Approval of the method shall not relieve the contractor of full responsibility for proper application and workmanship of the materials in the manner specifically approved. All connector threads shall be treated with an approved silicone lubricant.
- I. The Contractor shall be responsible for providing an approved ground and ground bus bars at all newly installed systems insuring proper bonding to telecommunications facilities. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework. All grounds shall consist of a minimum 6 AWG copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground. Contractor must notify the Owner prior to making any changes in submitted system design and/or installation.
- J. All exposed J-boxes or enclosures shall have tamper resistant features and hardware. Tamper resistant fasteners to be Tamper-Proof pin-in-hex or pin-in-torx button head screws.
 - 1. Use of common wires for input or output circuits is not allowed.
 - 2. Configure all zones to be normally closed loop with an end of line resistor (EOL) at the most distant point of the zone.
 - 3. The Contractor shall obtain Owner's permission before proceeding with any work necessitating cutting into or through any part of building structures such as girders, beams, concrete or tile floors and partition ceilings.
 - 4. The Contractor shall exercise reasonable care to avoid any damage to Owner's property. Contractor shall be responsible for and repair all damage due to carelessness of workers. Contractor will report to Owner any damage to the building, which may exist or may occur during the occupancy of the quarters.
 - 5. The Contractor shall be responsible for proper electrical grounds.

6. The Contractor shall take necessary steps to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.
7. The Contractor shall install the materials in accordance with the manufacturers' specifications.
8. The Contractor shall promptly correct all defects for which the Contractor is responsible.
9. The Contractor shall insure that all records and reports, City relations, engineering, metering, inspections, testing, quality or service standards and safety measures comply with standards applicable for the State of Texas.
10. The Contractor shall coordinate all work with Owner's designated representative.
11. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap wire, etc., and dispose of such items on a daily basis.
12. All work shall be done in a thorough and conscientious manner according to industry standards and shall be subject to inspection and acceptance.
13. The Contractor shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
14. The installation crew should include at least one installation supervisor, or lead technician, for on-site management of the project at all times.
15. The Contractor shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.
16. The Contractor shall maintain conductor polarity in accordance with industry practices.
17. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the distribution system.
18. The Contractor shall be responsible for labeling all cable, distribution devices, enclosures and outlet locations, according to industry standards. Numbering scheme shall be coordinated with Owner's representative before installation.
19. It shall be the responsibility of the Installation Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
20. The Contractor shall not roll or store cable reels without an appropriate underlay.
21. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
22. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement facilities. Failure to follow the appropriate guidelines may require the Contractor to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation Contractor during the implementation.

23. The Contractor shall be responsible for testing all cable prior to the installation of the cable. If the Installation Contractor fails to perform this testing operation, the Installation Contractor shall accept the cable as good and assume all liability for the replacement of the cable should it be found defective at a later date.
24. The Contractor shall plug conduits where cabling has been installed by the Installation Contractor in all equipment rooms and other cable entrance locations with re-enterable duct seal of flame retardant putty.
25. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.
26. Wiring, materials, and equipment will be delivered and stored in a clean dry space. They will be properly packaged in factory fabricated type containers and protected from damaging fumes, construction debris and traffic until job completion.
27. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the manufacturer.
28. All wiring, materials, and equipment must be listed and labeled by a nationally recognized testing laboratory.
29. All installation techniques and fixtures shall result in ease of maintenance and ready access to all components for testing measurements. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be used unless specifically approved by Owner. All parts shall be made of corrosion resistant material, such as plastic, anodized aluminum or brass. All materials used in installation shall be resistant to fungus growth and moisture deterioration.
30. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.
31. The cable pulling operation shall be performed such that a minimum bending of the cable shall occur in the unreeling and pulling operations. The pulling tension shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable.
32. Jacketing and insulation shall satisfy the Underwriters Laboratories (UL) listed fire rated cable insulation requirements in plenum areas.
33. Any pulling compound or lubricant used in cable installation shall not deteriorate the conductor or the insulation.
34. Parts and components not specifically mentioned in these specifications, which are required to provide a complete unit, shall be included as a part of the equipment to be furnished.
35. Nothing in the specification shall relieve respondents of system package design responsibility, including, but not limited to, all equipment furnished under this contract. The successful respondent is, in all cases, solely responsible for the performance of the delivered system, and for furnishing complete system documentation for each and every part of the system.

3.2 INTERFACES WITH OTHER PRODUCTS

- A. Interface installation of video surveillance with security access and intrusion detection systems.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of manufacturer's technical representative to prepare and start systems and supervise final wiring connections and system adjustments.

3.4 ADJUSTING

- A. Adjust manual lens irises to meet lighting conditions.

3.5 DEMONSTRATION

- A. Demonstrate system operation and provide two hours of instruction with manufacturer's training personnel.
- B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

3.6 WEEKLY CONSTRUCTION MEETING

- A. The Security Consultant and/or Owner will hold weekly construction meetings to review the installation schedule. It is mandatory that the Contractor's project manager attend each meeting.

3.7 SITE INSPECTION

- A. Continuously verify that the site conditions are in agreement with the Contract Documents and the security system design. Notify Owner's representative immediately of conditions that affect the performance of the installed system.
- B. Coordinate any required work that is not specified in the Contract Documents.

3.8 COORDINATION

- A. Adequate conduit and back boxes are provided for the specified system installation.
- B. Verify value of end of line supervision module with Owner.
- C. Adequate power has been provided for the specified system installation.
 - 1. Verify mounting location of all devices with Owner prior to installation.

3.9 IDENTIFICATION, LABELING AND DOCUMENTATION

- A. The Contractor shall label all termination devices, panels, enclosures and equipment rooms. The Contractor will mark each unit with permanently attached markings that will not impair the equipment or present a hazard to maintenance personnel.
- B. Place wire identification numbers on each end of all conductors by using sleeve type heat shrinkable markers. Install markers to be readable from left to right or top to bottom. Wire

numbers shall be computer printed (Brady TLS2200 with Permasleeve cable marking labels or equivalent). Hand written labels are not acceptable.

- C. Mark all spare conductors.
- D. If changes occur prior to acceptance testing altering the documentation previously furnished, the contractor shall formally update and reissue the relevant documentation to the Security Consultant and Owner.
- E. Security Consultant and Owner will review all documentation for accuracy and completeness and may reject substandard submittals.
- F. The Contractor shall establish and maintain complete system documentation, including documentation procedures, operational information, configuration information, historical records, and drawings. Documentation shall include the following:
 - 1. Floor plan drawings indicating device locations, unique system point numbers with device legends indicating manufacturers and model numbers for each device.
 - 2. The unique system point number of a device shall identify either through the software or hardwire connection, the specific device or group of devices associated with the unique point number in the system.
 - 3. Floor plan drawings indicating conduit and wire routing and junction box locations.
 - 4. Wire routing shall include cable identification and terminal strip numbers.
 - 5. Mounting details for all equipment and hardware.
 - 6. Functional block diagrams for each system.
 - 7. Wiring details showing rack elevations, equipment wiring and terminations and inter-rack wiring.

3.10 SECURITY SYSTEM PROGRAMMING

- A. Security System Programming to include commissioning of all controllers, points and related devices.
- B. All system programming shall take place in the field to verify Owner-designated zones for all devices. Programming shall be developed with Owner's input and shall not be accepted without Owner's approval.

3.11 WARRANTY

- A. The Contractor shall warrant the system for parts and labor for one (1) year. Warranty commences at the time of substantial project completion and acceptance by Campus Safety Systems Manager. Nothing shall be construed to limit this obligation to a shorter period.
- B. Warranty service shall be rendered on-site by request of Owner to repair or replace any defective materials, equipment and workmanship without cost to the Owner University, unless the Owner has previously given the Contractor a written acceptance of such condition.
- C. The Owner shall give prompt notice of the defect(s) either verbally or in writing to Contractor.

- D. Contractor shall purchase and provide to Owner one spare camera per type purchased. Spare cameras will be held by Owner for use by Contractor during warranty period. Contractor to replace spare parts used with new. Spare parts are property of Owner.
- E. Perform preventative maintenance during the warranty period, which includes:
 - 1. Quarterly cleaning and inspection of all devices.
 - 2. Quarterly inspection, cleaning and testing of all power supplies/UPS.
 - 3. Quarterly test and replace of batteries as necessary.
 - 4. Clean and vacuum MDF console and rack equipment
 - 5. Service technician performing service / warranty work shall check-in and out for each visit.
 - 6. Provide a written report to Owner documenting any work performed during the warranty period within 24 hours of such event. Report shall detail work performed, equipment repaired or replaced, etc.
 - 7. Provide loaner equipment which is equivalent to the malfunction equipment for any equipment not field repairable.
 - 8. Repair or Replacement Service
 - a. Repair or replacement service during the warranty period shall be performed 7 days a week, 24 hours a day and with a 4 hour response time.
 - b. Emergency repair or replacement service during the warranty period shall be performed 7 days a week, 24 hours a day and with a 1 hour response time.
 - c. If the Contractor can not restore system operation during the warranty period within 2 business days of the system failure, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
 - d. 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 the expansion is performed by an authorized dealer for the affected equipment.
 - e. On-line software and hardware service shall be provided and shall be password protected and controlled by the Owner.

3.12 TECHNICAL VERIFICATION SESSION

- A. Security system walk through and verification shall be provided for the UIT PM and Campus Safety Manager and shall minimally consist of 4 ea. 1-hour session.
- B. A complete product manuals and preliminary as-built drawings shall be delivered to the owner one week prior to the training sessions.
- C. Technical verification and walk through shall consist of:

1. Technical explanation sufficiently thorough that: staff personnel shall be able to identify and trace circuits, analyze malfunctions and make changes as necessary to maintain system operation.
2. Provide printed reference material for each trainee that documents and explains in technical terms:
 - a. System block diagram with technical features
 - b. Method and record of end-to-end testing
 - c. Review of as-built drawings.
 - d. Q & A session.

3.13 SUBSTANTIAL COMPLETION

- A. Work must meet the following requirements to qualify for the Owner's consideration of Substantial Completion:
 1. All cameras and monitoring devices shall be fully installed, tested and fully operational
 2. Video cameras powered and focused as approved by the Campus Safety Manager.
 3. End to end testing reports produced
 4. Technical verification process complete.
 5. Owner may utilize the system for its designed intent.
 6. Contractor will provide a list of remaining work items and approximate completion date.
 7. Contractor will certify in writing that all remaining work is minor in nature and will be completed in less than 30 days.

3.14 TESTING REQUIREMENTS

- A. The contractor shall perform sample tests in the presence of the Security Consultant and Owner. Performing the testing procedures specified herein assures that the communication cabling and system electronics meets the performance characteristics specified. All testing shall comply with EIA/TIA Standards and that of the equipment manufacturers. If testing indicates that the performance characteristics are not met, the test shall be failed test and any other test that may be affected by the modification and/or repair shall be rerun and verified.
- B. Test equipment will be provided by the contractor to test and to certify the 100% operational condition of all materials and equipment.
- C. The Vendor shall prepare and submit all test procedures and data forms for the pre-installation, post installation and subsystem test to Owner. The test procedures shall have Owner approval before the tests.

3.15 SYSTEM CHECK OUT AND VERIFICATION

- A. Commission all security devices from field up to and including the head-end.
- B. Contractor supplied "As Built" Drawings shall show security conduit routing and cable labeling.
- C. Review all as-built and testing documentation with Owner. Revise and reissue as required.
- D. Video camera image as received at the head-end is noise free, focused and field of view of view is optimized for intended content.

3.16 ACCEPTANCE OF SYSTEMS

- A. Each area of construction completed and submitted as complete shall meet the following criteria under testing:
 - 1. System must meet all specifications as described in these instructions.
 - 2. Operational prints, manuals, signal logs, and as built prints must be furnished.
 - 3. Visual testing and signal verification will be conducted at random locations to determine that equipment performs satisfactorily.
 - 4. Specifications set forth for construction of the system have been devised in order to insure system compatibility and performance. Compliance to these specifications will be determined during periodic observances of construction. Repeated failure to comply with the specification will be considered before the initial acceptance phase of the plant commences.
 - 5. Within ten days receipt of the final acceptance notice, the Owner's representatives shall schedule and perform the final inspection. When the work is found acceptable under the contract documents and the contract is fully performed, the project will be declared complete.

END OF SECTION 282300

SECTION 283100 – ADDRESSABLE DEVICE FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements” govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: The extent of fire alarm system work is as shown and scheduled and includes, but is not limited to, providing a system with the following functions and operations:
 - 1. Provide a complete distributed microprocessor based, 24 volt dc, closed circuit, and electrically supervised, addressable device multiplexed fire alarm to be wired, tested, and left in first class operating condition. The system shall include, but not be limited to, a control panel with reserve standby power, firefighters' HVAC system override, annunciators, manual alarm stations, ceiling smoke sensors, duct smoke sensors, heat sensors, addressable input and output devices, sprinkler water flow switches, valve supervisory switches, audible and visual alarm indicating devices, raceways, wiring and all hardware and software as required to effect an operational system as herein specified. Each alarm device shall be individually addressable.
 - 2. The system shall operate as an addressable, continuous sounding system which will sound alarm devices until manually silenced, as herein specified.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the latest edition of the following standards:
 - 1. National Fire Protection Association Standards:
 - a. NFPA 70 National Electrical Code
 - b. NFPA 72 Installation, Maintenance and Use of Protective Signaling Systems.
 - c. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - d. NFPA 101 Life Safety Code.
 - e. NFPA 13 Sprinkler Systems.
 - 2. Underwriters' Laboratories, Inc. Requirements and Listing for use in Fire Protective Signaling Systems as follows:
 - a. UL 864 Control Panels.
 - b. UL 268 Smoke Detectors - Systems.
 - c. UL 268A Duct Smoke Detectors.

- d. UL 217 Smoke Detectors - Single/Multiple Station.
 - e. UL 521 Heat Detectors.
 - f. UL 228 Door Holders - Closers.
 - g. UL 464 Audible Signaling Appliances.
 - h. UL 1638 Visual Signaling Appliances.
 - i. UL 38 Manual Alarm Stations.
 - j. UL UOJZ. Fire Alarm control unit
- 3. International Building Code, latest edition and the requirements of state and local authorities having jurisdiction.
 - 4. Comply with requirements of the Americans with Disabilities Act of 1990.
 - 5. State of Licensed refers to State of Maryland.
 - 6. AHJ refers to Baltimore City Fire Marshal's Office.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: The equipment specified herein shall be approved by Facilities Planning & Construction in coordination with the Fire Marshal, and constitutes the style of operation, quality of construction, features and physical size limitations required for this project.
- B. UL and FM-listing: All fire alarm system components shall be UL and FM listed for fire alarm use. The UL listing shall be under category UOJZ to assure that the entire system has been tested as an integral life safety system.
- C. All equipment furnished shall be the current standard products of a single manufacturer and shall bear the label of the Underwriters' Laboratories for use in fire alarm system designed in compliance with the requirements of NFPA codes. Raceways, wiring and terminations shall be accomplished in compliance with the requirements of the National Electric Code, Article 760.
- D. The system as installed shall, upon completion, be certified by a state licensed fire alarm technician to the Owner as being installed in compliance with the specification, the requirements of all state and local codes, and as being operational and free from defects.
- E. All system equipment supplied shall be listed by the Underwriters' Laboratories for NFPA 72 system use, and all applicable NFPA Codes.
- F. The installing contractor shall be authorized and designated representative of the fire alarm system manufacturer to sell, install and service the manufacturer's equipment and shall stock the required spare parts to keep the system in operation. The installing contractor shall maintain a staff of specialists for technical assistance and system maintenance.
- G. The installing contractor must be licensed by the State Fire Marshal to sell, install, and service fire alarm systems.

- H. The installing contractor shall have on his staff a minimum of five fire alarm technicians who are licensed by the State Fire Marshal's office for such purpose and under whose supervision installation, final connections and check out will take place.
- I. The installing contractor or equipment supplier shall have a staff a minimum of one certified NICET Level III state licensed fire alarm planner under whose supervision system design shall take place. In lieu of a NICET-certified state licensed fire alarm planner, the contractor or supplier may provide design by a professional engineer systems and practices as they pertain to life safety and to fire protection, detection, alarm, control and extinguishment.
- J. The equipment supplier shall provide 24 hour, 365 days per year emergency service with qualified and state-licensed service technicians.
- K. The installing contractor shall have been actively engaged in the business of selling, installing, and servicing microprocessor and multiplex fire alarm systems for at least 8 years and shall have proof of experience in the installation and maintenance of the type of fire alarm system specified herein.
- L. The manufacturer or his representative shall maintain within 50 miles of the installation, a staff of factory trained, state licensed fire technicians, together with all support parts necessary for maintenance of the system.
- M. Where approved in writing by the system manufacturer and installing contractor, the Electrical Contractor may install all conduit and boxes. The system wiring shall be pulled in by the installing contractor. All system connections, device installation, system start-up and testing shall be performed by the installing contractor. Rough-in by the electrical contractor shall not in any way affect the system manufacturer's and installing contractor's full responsibility for the installed fire alarm system.
- N. The manufacturer shall submit legal documentation indicating that the purchased fire alarm equipment will be provided with parts, and support for 10 years after the acceptance by the Owner.
- O. Plenum cable is acceptable where allowed by NEC and Authority Having jurisdiction (AHJ). All wiring shall be listed for limited energy fire alarm use and rated for 300 volts minimum.
- P. The complete combination fire alarm system shall comply with NFPA 72 National Fire Alarm and Signaling Code, and Baltimore City Fire Alarm Rules. Modifications required to provide compliance shall be made at no cost to the Owner. Where Contract Document requirements are in excess of Code requirements the Contract Documents shall govern.

1.5 SUBMITTALS:

- A. Shop Drawings submittals shall include, but not be limited to, the following:
 - 1. A written description of the system operation (written in this specification format), with all exception and/or deviations clearly highlighted or identified.
 - 2. A block diagram showing system components, wire runs, wire counts and wire sizes.
 - 3. A control panel layout diagram showing the location of all modules and wiring and interconnection schematics.

4. Calculations justifying battery size, power supply size, amplifier size, voltage drop and wiring sizes based on worst case occurrence.
5. Manufacturer's descriptive literature for all panels, modules and peripheral equipment describing size, color, finish, capacity and electrical characteristics.
6. A complete listing of all associated software showing the relationship of alarm points, control outputs, control inputs and indicators.
7. An alarm matrix showing alarm and control function for an alarm in each device/zone.
8. Scaled floor plan drawings locating and naming each device and showing wiring and conduit sizes from each device back to the control panel(s).
9. A complete riser/wiring diagram showing zoning and addressing and wiring and conduit sizes from the CPU to all remote terminal units, graphics terminals, CRT displays, printers, and other system devices.
10. Completely identified and marked catalog cuts of all associated equipment and devices, with all non-applicable items crossed out, or applicable devices clearly highlighted and/or identified.
11. Complete and detailed point-to-point wiring diagrams for all devices in the system.
12. Complete Bill of Material for all equipment.
13. A copy of the form to be used for final tests, 100% audit and checkout shall be submitted for approval.
14. Additional information as required in Section 26 01 00.
15. Two hard copy plans and one electronic copy that are stamped and signed by a Registered Professional Engineer shall be submitted to AHJ before construction can begin.
16. Contractor must obtain a fire alarm installation permit (permit fee may apply) before construction can begin.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Deliver fire alarm system components in factory-fabricated containers.
- B. Store in a clean, dry space and protect from the weather.
- C. Handle control and annunciator panels carefully to avoid damage to material components, enclosure and finish.

PART 2 PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Provide the required fire alarm system products in the sizes and capacities required or indicated, complying with the manufacturer's published product information of standard materials and components, designed and constructed for the applications indicated.

- B. Manufacturers: Notifier or approved equivalent.

2.2 SYSTEM OPERATION:

- A. Activation of an "intelligent" smoke detector shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):
 - 1. When an "intelligent" smoke detector senses an abnormal level of smoke, the loop interface module shall automatically initiate a "check" mode. Consecutive samples shall be made of the prospective detector. Upon completion of consecutive smoke trouble conditions, the detector is considered "checked" and the system go directly into an alarm mode, unless the verification mode is activated for the detector.
 - 2. Alarm verification shall be programmable by detector(s) to initiate a verification sequence after the "check" procedure and the Fire Alarm Control Panel shall be permitted with permission from AHJ. The system common alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm condition including: device type, device location and time of alarm. Location and zoning messages shall be custom field programmed to respective premises.
 - 3. Appropriate status change message(s) shall be transmitted to the monitoring locations located at Police Dispatch and the building.
 - 4. Activate all audible alarm devices on general alarm or the floor of alarm, the floor above and the floor below with a prerecorded alarm message. General or selective evacuation shall be determined by the AHJ during the submittal process.
 - 5. Activate all visual alarm devices on general alarm or the floor of alarm, the floor above and the floor below. General or selective evacuation shall be determined by the AHJ during the submittal process.
 - 6. Activate addressable output relays to unlock all locked security doors.
- B. Activation of any addressable manual pull station, beam smoke detector, sprinkler water flow switch or "intelligent" heat detector shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):
 - 1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.8 to occur.
- C. Activation of an elevator machine room or shaft heat detector shall cause the following operations and indications:
 - 1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.8 to occur.
 - 2. Initiate via an addressable output relay, the shunt tripping of power to each elevator machine.

- D. Elevator recall shall be initiated via addressable output relays when any smoke detector elevator lobby, in the elevator machine room or in elevator shafts is activated. Elevator recall shall be indicated on the alpha-numeric display and shall be as follows:
1. Passenger and Freight Elevators shall recall to the First Floor for lobby initiating device alarms on all levels above the First Floor.
 2. Passenger and Freight Elevator shall recall to the First Floor for lobby initiating device all alarms below the First Floor.
 3. Passenger and Freight Elevator shall alternately recall to the Second Floor for alarms from the first floor lobby initiating device.
 4. Activate relay to provide signal to elevator cab that smoke detector in the machine room or elevator shaft is in alarm.
- E. Smoke doors on all floors shall be closed by opening of the addressable output relay powering their magnetic hold open devices whenever the smoke detector on either side of the door is activated or the building smoke exhaust system of the floor is activated.
- F. Air handling units shall be shutdown via addressable output relay whenever the unit duct smoke detector is activated, on general alarm, or the building smoke exhaust system on the floor served by the unit is activated.
- G. Closure of a supervised OS&Y or PIV valve sensed via a supervisory switch or loss of supervisory air pressure in a dry-pipe sprinkler system, sensed via a pressure switch shall cause the following operations and indications:
1. The system supervisory alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the supervisory alarm condition shall silence the audible supervisory device and revert the flashing supervisory alarm LED to a steady state.
 2. An alpha-numeric LCD Display shall indicate all applicable information associated with the supervisory condition including: device type, device location, and time of alarm. Location messages shall be custom field programmed to respective premises.
 3. Appropriate status change message(s) shall be transmitted to all graphics terminals displays monitors, and printers.
- H. The presence of a ground condition or an open circuit on any alarm initiation circuit or a ground condition, open circuit or short circuit on any alarm indicating circuit, blockage, lens contamination or physical misalignment of any beam type smoke detector, a trouble condition at a fire suppression system panel or other trouble condition shall cause the following actions and indications:
1. The system common trouble LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the trouble condition shall silence the audible trouble device and revert the flashing common trouble LED to a steady state.
 2. An alpha-numeric LCD Display shall indicate all applicable information associated with the trouble condition and its location. System trouble diagnostics shall assist in defining the trouble condition. Unacknowledged alarms/messages shall have priority over any trouble

displays and take precedence on the LCD annunciator. Trouble conditions will be stored in memory for future recall/ display.

3. Appropriate status change message(s) shall be transmitted to the monitoring locations at Police Dispatch and the Fire Alarm Panels.
 - I. All designated "nonsilenceable" auxiliary control functions shall remain in operation (even upon silencing of audible alarms) until such time as the control panel is cleared and reset manually (i.e. fan control outputs, central station interface, elevator recall interface, etc.).
 - J. Provisions shall be included within the Fire Alarm Control Panel for the following

2.3 MANUAL CONTROLS IN ADDTION TO PRESVIOUSLY MENTIONED:

- A. Disconnect audible signaling while testing.
- B. Temporary software bypass of selected alarm points.
- C. Software assignment of selected alarm points to alarm verification function as a method of tracking alarms caused by environmental factors or maintenance requirements. Waterflow switches, smoke detectors, and valve supervisory switches shall be assigned to the verification group to eliminate nuisance alarms.
- D. Any zone may be enabled or disabled remotely via the monitoring locations.

2.4 SYSTEM DEVICES:

- A. System devices shall be located as shown on the Drawings. The Contractor shall refer to all the drawings to determine where devices are to be located. All system devices shall be numbered with a unique number. The numbering system shall include the building area, type of device, and device number. This numbering system shall be shown on each submitted floor plan drawing, fire alarm riser diagram and be tabulated. The tabulation shall be included in each O&M Manual submitted to the Owner.

2.5 SYSTEM ZONING:

- A. The system shall employ "intelligent" heat and smoke detectors and addressable interface devices capable of being recognized and annunciated at the main control panel and monitors on an individual basis. All devices shall be field-programmed into software zones for the purpose of general area identification and annunciation. However, each device shall also be identified on an individual basis including exact location and device type. All device location information shall be totally field programmable to exact job requirements.
- B. Initiating and monitored devices shall include, but not be limited to, the following:
 1. Manual pull stations.
 2. Ceiling smoke detectors.
 3. Duct smoke detectors.
 4. Ceiling heat detectors.
 5. Beam smoke detectors.

6. Addressable input devices.
 7. Sprinkler flow and pressure switches.
 8. Valve supervisory switches.
 9. Fire suppression system panels.
- C. Remote panels shall communicate with the main CPU via the data loop and be capable of being intermixed on the same loop as intelligent heat and smoke detection and control modules.
- D. Output devices shall include, but not be limited to, the following:
1. Ceiling alarm speakers.
 2. Wall and ceiling alarm speakers/visual signals.
 3. Visual alarm devices.
 4. Addressable interface relays.
 5. Monitoring Locations.

2.6 SYSTEM CONFIGURATION:

- A. System equipment shall include, but not be limited to an operator's control/system control panel, remote panels, remote power supplies, monitoring locations, HVAC override, battery backup, alarm indicating devices, door hold opens and output AE Project Number: Addressable Fire Alarm System relays and other devices required to provide a complete and working system.
- B. The system control unit shall be connected to remote panels on a looped signaling line circuit. The wiring of the loop shall be so arranged that additional panels may be inserted in the loop without requiring additional wires to be installed between panel and the system control unit. In addition, loops shall be so arranged that any wiring fault on a loop shall not disable more than 250 initiating devices. A single open ground or multiple opens in different wires at the same location shall not prevent receipt of alarm signals from that loop.
- C. The system shall be of the active multiplex/addressable type wherein each initiating device shall be repetitively scanned, causing a signal to be transmitted to the control unit that indicates the individual initiating device circuit installation wires are intact. Loss of such a signal at the system control unit shall result in a trouble indication as specified hereinafter for the particular initiating device affected. All initiating devices in the system shall transmit their normal, trouble or actuated status signals in no less than 5 second intervals.
- D. Each individual smoke detector shall be of the analog type so that the system can be used to read smoke levels on a real time basis from selected smoke detectors for maintenance and diagnostic purposes. All smoke detectors and other initiating devices shall be individually indicated at the main control panel, the color graphics unit and each DGP, when changing to an alarm or trouble state.

2.7 FIRE ALARM SYSTEM CENTRAL EQUIPMENT:

- A. General: The Fire Alarm Control Panel shall be modular in design utilizing distributed solid state microprocessors and be capable of future expansion. The microprocessor-based CPU shall be completely field-programmable. CPU module shall provide for programmable nonvolatile RAM memory utilizing integral lithium based memory IC chips. Each panel module shall be independent employing its own microprocessor circuitry for reliability and independent operation in case of main CPU failure. The system control unit shall have capacity for the required active detection and output points with space for future use and expansion. The control unit shall be listed to the latest UL 864 Standard. All circuitry shall be UL listed for power-limited application and use positive temperature coefficient devices for current limiting. The panel shall be provided with keylock hinged door to access system controls/switches. The panel door shall be provided with a transparent window for viewing all alarm, trouble indicators, and LCD annunciator. The control unit shall be designed for semiflush mounting.
- B. Central Processing Unit Module (CPU): The CPU shall communicate with, monitor and control all other modules in the panel via internal serial communications techniques.
- C. Removal, disconnection, or failure of any control panel module shall be detected and reported by the CPU.
 - 1. The CPU shall contain and execute all custom control-by-event programs for specified events if a fire situation is detected in the system.
 - 2. Such programs shall be held in nonvolatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
 - 3. The CPU module shall contain a real-time clock circuit to time/date stamp system events and execute custom time control programs. Time control program events shall be terminated in a fire conditions.
- D. Display Interface Board (DIA): The DIA shall provide all touchpad controls and indicators used by the system operator and may also be used to program all control panel and system parameters.
 - 1. The DIA shall contain, and display, custom alphanumeric labels for all intelligent detectors and addressable modules. Such label information shall be stored in field-programmable nonvolatile memory.
 - 2. The DIA shall provide a minimum of an 80 character alphanumeric Liquid Crystal Display (LCD).
 - 3. The DIA shall provide Light-Emitting Diodes (LEDs) for ac power, system alarm, system trouble, display trouble, and disable.
 - 4. The DIA shall provide status readouts, manual control action, and entry of any alphabetic or numeric information. The keypad shall include means to enter passwords to prevent unauthorized manual control or programming.
- E. Serial Interface Board (SIB): The SIB shall provide the following interfaces:
 - 1. Two ports for remote printer/CRT devices (RS-232c).
 - 2. Two ports for future local printer (RS-232c).

- F. Loop Control Module: Loop Control Module shall be provided to monitor and control multiple loops of addressable initiating and control devices, up to 250 devices per loop. Allow at least 10% spare capacity per loop for future expansion.
 - 1. The Loop Control Module shall communicate and provide power to all devices on its Style 4 loop over a single pair of wires. For dynamic Style 4 supervision the loop may be branch-circuited or "t-tap" connections may be made off of the loop. Loop wiring shall be twisted shielded pair of up to 10,000' in length.
 - 2. The Loop Control Module shall receive digital information from all "intelligent" detectors and shall process this information to determine normal, alarm, trouble and sensitivity conditions. The analog information shall also be used for automatic test and determination of maintenance requirements.
 - 3. The Loop Control Module module shall individually monitor all "intelligent" detectors for analog sensitivity variation initiating a "Near Dirty" and a "Dirty" trouble signal. The system shall adjust alarm sensitivity threshold of the detectors sensitivity, in this case to ensure that false alarms are not created due to dirty detectors, nor reducing the overall alarm threshold.
 - 4. The Loop Control Module shall communicate continuously with each "intelligent" detector and addressable module on its loop and verify its proper function and individual status. Communication with up to 250 such devices per loop.
- G. Modular Network Card: The modular network card shall be provided to allow the voice communications system and network information to direct communications through this fire alarm system and future fire alarm systems.
- H. Control Switches: Provide the following control switches at the Fire Alarm Control Panel.
 - 1. Acknowledge switch.
 - 2. Signal silence switch.
 - 3. System reset switch.
 - 4. System test switch.
- I. Walk Test: The system shall include a special "walk test" mode where each initiating device is manually placed in alarm. The control panel pulses the system audible devices on detection of each such alarm and automatically resets the panel, permitting a single serviceman to functionally test the entire system.
- J. Automatic Detector Test: The system shall include a special automatic detector test features which permits reading and adjustment of the sensitivity of all intelligent detectors from the main control panel. In addition, the automatic test feature shall also permit the functional testing of any "intelligent" detector or addressable interface device individually or by zone from the main control panel. Results of the test are then indicated on the LCD display. A printout of all test data shall be capable via the system printer at either existing monitoring location. Special System Reports: The system shall have the ability to generate and print, upon command, system and point status reports.

1. Selection of "system" read status provides the operator with global system programming information including: alarm verification, SLC loop styles, number of SLC loops, number of software zones, number of auxiliary power supplies, signal silence inhibit.
 2. Selection of "point" read status provides the operator with selected individual point programming data including: point status (normal, alarm, trouble, disabled, etc.), address, type I.D., control by event, custom alphanumeric label, verification status, alarm threshold level, sensitivity, silenceable/nonsilenceable, SLC loop number, and device number.
- K. System Diagnostics: The system shall include special software to detect, diagnose, and report failures and isolate such failures to a printed circuit board level.
1. Each module via its resident, independent processor shall periodically perform independent self-test routines as a self-operational/performance test. Any irregularities are reported via the LCD display and trouble indicators.
 2. A lamp test function shall be provided to test all system indicators including the LCD display. This function shall also test the panel trouble device for proper operation.
 3. A keypad test function shall also be provided allowing the user to interactively confirm that all keys are functional and operating correctly.
 4. The system shall include independent "Watch-Dog" timer software to detect and report failure of any microprocessor circuit, memory, or software. The function of this safe-guard software/circuitry is to then restart the respective processor and maintain proper operation of the system. In addition, the master CPU has control over a hardwired reset terminal which can perform a system-wide restart.
- L. Field Programming: The system shall be 100% field-programmable or programmable from the monitoring locations.
1. All programs shall be stored in nonvolatile RAM memory, with a dual partition to allow for switching between partitions to avoid necessity for panel being offline during programming.
 2. Programming shall be accomplished only after entering an appropriate and preselected five digit password security code.
 3. All programming functions shall be initiated via special system "prompting" menus via the system main CPU. The system shall be capable of direct English language programming and prompting and not require complex digital equations or special formulations.
 4. The system shall provide a means to "review" all programmed functions.
 5. Any addressable indicating circuit or auxiliary addressable relay shall be programmed to activate on alarm of a single initiating device or a combination of initiating devices.
- M. Event History: The main fire alarm panel shall have the resident ability to store a separate alarm for alarm, trouble, and supervisory events in independent history logs.
1. Event history shall include all system alarms, troubles, operator actions (i.e. acknowledge, silence, reset, program entry, etc.), unverified alarms, circuit/point alterations, component failures.

2. Events shall be time and date stamped and be capable of being recorded and/or reviewed without purging the history file.
 3. Events shall be stored in non-volatile buffer memory. Access to history buffer shall be secured via five digit password security code.
 4. Event recording shall automatically overwrite the oldest event(s) in memory.
- N. Power Supply: The power supply for the panel and all fire alarm peripherals shall be integral to the control panel.
1. The power supply shall provide all control panel and peripheral power needs with filtered power as well as 3 amperes of regulated 24 volt dc power for external audio/visual devices. The audio/ visual power may be increased as needed by adding additional modular expansion power supplies.
 2. All power supplies shall be designed to meet UL and NFPA requirements for power-limited operation on all external signaling lines, including initiating circuits and indicating circuits.
 3. All circuitry shall be UL listed for power-limited application and use positive temperature coefficient devices for current limiting. Fuses or other thermal overload type protection shall be unacceptable.
 4. The system shall derive its primary operating power from a 120 volt ac, single phase, 60 Hz supply. There shall also be a 24 volt battery standby power source with internally supervised batteries and automatic charger, capable of operating the entire system for a minimum of 24 hours in the supervisory mode and then be capable of operating the alarm devices for a minimum of 15 minutes.
 5. The power supply unit shall contain suitable overvoltage protection to prevent any malfunction or damage which might occur from line power surges (lightning).
 6. Upon loss of main power, the power supply unit shall automatically revert to battery power and the system shall remain fully operational.
 7. When the ac power is restored, the control unit shall automatically revert to normal operation without requiring any manual restarting procedures.
 8. The battery shall be automatically charged by a built-in short-circuit-proof charger.
 9. The charging current shall be automatically controlled according to the battery's ambient temperature.
 10. After a full discharge, the system shall be able to recharge the batteries completely within 24 hours.
 11. The connection to the battery shall be automatically switched off when the voltage drops below 19 volts to protect battery cells from damage to deep discharge.
 12. Sealed lead acid batteries shall be used for emergency power source.
 13. The entire power supply charger circuits including fuses shall be supervised both positive and negative ground fault supervision, battery/charger fail condition, ac power fail indicators. The power supply shall also provide supervision of modular expansion power

supplies as may be required. Any malfunction or blown or missing fuses shall result in a fault indication on the control unit.

2.8 FIREFIGHTER'S TELEPHONE SYSTEM:

- A. Shall not be required by (AHJ).

2.9 FIREFIGHTERS' HVAC OVERRIDE

- A. The emergency communications panel shall provide complete firefighters' manual control override and status for building smoke control systems and be integral to the main fire alarm control panel.
- B. Each auxiliary function shall be capable of being activated or deactivated manually by selection of the respective circuit via the electronic touchpad controls. The system shall provide ability to shutdown or start designated emergency fans and have the ability to override and reverse any automatic start/ shutdown function. Each firefighters auxiliary control circuit shall be supervised.
- C. Each controlled fan and system shall incorporate a supervised "confirmed status" LED indicator. Status indicator shall be annunciated when the fan or system is in the "on mode".
- D. All necessary interfaces between the fire alarm/communications system and firefighters' override controls shall be provided herein as required. The firefighters' override controls shall be completely interfaced with the building Control and Automation System. The firefighters' override system shall be wired as a low voltage 24 volt dc system.
- E. Firefighters' HVAC override controls and confirmed status indicators shall be as follows:
 - 1. Status indicators for each of the two stairwell pressurization fans. Status indication shall be from a dry contact in the fan starter.
 - 2. On/Off/Auto control by unit for the outside air handling unit and each of the exhaust fans. Status indication shall be from a dry contact in the air handling unit starter.
 - 3. Off/Auto control unlock all electrically secured doors. Status indication shall be provided from system software.
 - 4. Close/Auto control to close all held open doors and fire/smoke shutters.
 - 5. Status indication shall be provided from system software.

2.10 MONITORING LOCATIONS:

- A. System shall be annunciated and controlled at the Security office and as required by Onwer.

2.11 DISPLAY/KEYBOARDS:

- A. Will be required.

2.12 PRINTERS:

- A. Will be required.

2.13 REMOTE ANNUNCIATORS:

- A. As shown on plans.
- B. Graphic Annunciator:
 - 1. Refer to drawings.

2.14 SMOKE AND HEAT SENSORS/DETECTORS

- A. Intelligent "Ceiling-mounted" Photoelectric Smoke Sensors: Analog photoelectric smoke sensors shall be provided where indicated on the Drawings.
 - 1. The intelligent photoelectric smoke sensors shall connect via two wires to one of the intelligent control panel loops.
 - 2. The sensors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 - 3. The sensor shall also provide a "Near Dirty" and "Dirty" feature whereby the detector shall initiate a trouble condition should the units sensitivity approach the outside limits of the normal sensitivity window.
 - 4. The sensor shall be provided with extensive RF and EMF noise reduction circuitry.
 - 5. The sensor shall employ sophisticated self-compensating solid state LED light source and photosensitive circuitry.
 - 6. The sensor/control panel shall provide a calibrated test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself activated remotely on command from the control panel.
 - 7. The sensors shall provide address-setting means the sensors shall also store an internal identification code which the control panel shall use to identify the type of sensor.
 - 8. The sensors shall provide an alarm and power/status LED. Status LED shall flash under normal conditions, indicating that the sensor is operational regular communication with the control panel. The LED may and in regular communication with the control panel. The LED may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected and verified. The detector shall be capable of allowing an output connection shall be provided in the base for connecting an external remote alarm LED.
 - 9. The sensor shall be flush ceiling-mounted and be provided with modular detector head with twist-lock base. Sensors shall also be suitable for surface mounting below the raised floor or above the ceiling. Sensors shall be provided in smooth attractive white finish, and sealed against dirt, vermin, and back pressure. Sensors shall be provided with fine mesh insect/contaminate screen.
 - 10. Sensors shall be UL listed with respective control panel.
 - 11. Devices shall not be required in restrooms, individual offices, or shower rooms.

12. Devices located in corridors shall be spaced no more than 30 feet apart.
- B. Intelligent "Duct Mounted" Photoelectric Smoke Sensors: Duct-mounted intelligent photoelectric smoke sensor shall be provided where shown on the Drawings.
1. Sensors shall operate on the same principles and exhibit the same basic characteristics as area type "intelligent" smoke sensors. The unit shall be capable of interchanging/accepting either photoelectronic or ionization type sensors.
 2. The sensor shall operate in air velocities of 300 FPM to 4,000 FPM without adverse effects in detector sensitivity.
 3. Each sensor shall operate directly with the intelligent control panel loop, without an interface module.
 4. The unit shall consist of a molded plastic enclosure with molded integral conduit knock-outs. The unit shall be provided with clear faceplate cover to provide visual viewing of detector/sensor for monitoring sensor operation and chamber condition. The duct housing shall be provided with gasket seals to provide proper sealing of housing to mechanical ductwork and to ensure proper air flow into the detector sampling chamber. Duct housing shall be designed to easily mount to rectangular or round ducts. Where duct detectors are mounted in a location not easily accessed, provide a remote alarm test switch and LED in an accessible location.
 5. The duct sensor unit shall be UL listed to the most current UL 268A standard and be cross-listed for use with the fire alarm control panel.
 6. Each duct sensor unit shall be equipped with sampling tubes protruding into the associated ductwork. Sampling tubes shall extend the width of the duct. Sampling tubes shall be provided with integral porosity filter system to aid in reducing detector contamination. Sensors shall be installed per NFPA 90A.
 7. Each sampling tube will be supported on both ends.
- C. Intelligent Ceiling Mounted Heat Sensors: Analog thermal sensors shall be provided where indicated on the Drawings.
1. The intelligent thermal sensors shall connect via two wires to one of the intelligent control panel loops.
 2. The sensors shall use dual electronic thermostats to measure temperature levels in its chamber and shall, on command from the control panel, send data to the panel representing the analog temperature level.
 3. The sensors/control panel shall provide a test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the sensor itself or may be activated remotely on command from the control panel.
 4. The sensors shall provide address-setting means. The sensors shall also store an internal identification code which the control panel shall use to identify the type of detector.
 5. The sensors shall provide an alarm and power/status LED. Status LEDs shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. The LED may be placed into steady illumination by the control panel,

indicating that an alarm condition has been detected. The detector shall be capable of allowing an output connection shall be provided in the base for connecting an external remote alarm LED.

6. The sensor shall be semi-flush ceiling-mounted and be provided with modular detector head with twist-lock base. Sensors shall be provided in smooth white finish.
- D. Optical beam smoke detectors and an addressable input device shall be provided where indicated on the Drawings.
1. Detectors shall consist of a control unit, an infra-red transmitter unit and an infra-red receiver unit. Detector shall be powered at 24 VDC from the fire alarm system.
 2. Detector shall have a self-check and automatic compensation circuit to compensate for dust accumulation, component aging and temperature change.
 3. Detectors shall be installed to project a beam approximately 1 foot below the ceiling in the projected area and shall alarm when smoke in the beam path reduces the signal strength to between 40 and 93 percent for period of 5 seconds.
 4. The detector shall remain in an alarm condition until reset.

2.15 MANUAL STATIONS:

- A. Addressable Manual Stations: Flush mounted dual action manual stations with an addressable interface module or approved equal shall be provided where indicated on the Drawings.
1. Manual stations shall be an alternate color to the wall color they are installed on, for easy identification.
 2. The manual station addressable module shall connect with two wires to one of the intelligent control panel loops.
 3. The module at the manual station shall, on command from the control panel, send data to the panel representing the state of the manual station switch.
 4. The manual station addressable module shall provide address-setting means.
 5. All pull stations will require a UL and ADA listed pull station cover with integral piezo alarm.

2.16 INPUT/OUTPUT DEVICES:

- A. Monitor Module (Addressable input Device): Addressable monitor modules shall be provided where required to interface to contact alarm devices.
1. The monitor module shall be used to connect a supervised zone of conventional initiating devices (any N.O. dry contact device, including 4 wire smoke detectors) to an intelligent loop.
 2. The monitor module will mount in a 4" square electrical box.
 3. The monitor module shall provide address-setting means using a binary DIP switch.

- B. Control Module (Addressable Output Device): Control/relay modules shall be provided where required to provide audible alarm interface and/or relay control interface.
 - 1. The control module shall be used to connect a supervised zone of conventional indicating devices (any 24 volt polarized audiovisual indicating appliance) to an intelligent loop. The zone may be wired Class A or Class B field-selected. The control module may be optionally-wired as dry contact (Form C) relay.
 - 2. The control module will mount in a standard 4" electrical box.
 - 3. Power for the relay actuation shall be provided by the intelligent detector loop to reduce wiring connection requirements. Audio/visual power shall be provided by a separate loop from the main control panel or from supervised remote power supplies.
 - 4. The control module shall provide address-setting means
- C. Auxiliary Control Relays: Relays shall be provided for control interface. Relays shall be heavy duty type and rated up to 20 amps at 120 volts ac, 60 Hz. Relays shall be provided with NEMA 1 dust cover assembly and be provided with DPDT contacts.
- D. Sprinkler Water Flow and Pressure Switches: Switches shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor.
- E. Fire Protection OS&Y Valve Supervisory Switches: Switches shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor. Switches shall activate a supervisory signal within two turns of the valve or more than 1/3 of the valve travel toward the closed position.
- F. Fire Suppression System Panel shall be a networked fire alarm control panel that will reside on the existing fire alarm network and share point information and control with the monitoring locations and any panel on network.
- G. Fire Pump Controllers: Dry alarm and trouble output contacts shall be provided in the Fire Pump Controllers furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor.
- H. Elevator Recall: Addressable fire alarm system dry output contacts installed by this Contractor shall provide a recall signal to the elevators furnished and installed under Division 14.
- I. Security/Access Control Interface: Addressable fire alarm system dry output contacts installed by this Contractor shall provide an unlock signal to the Security/Access Control system furnished and installed under Division 11.
- J. Magnetic Door Holders: Low profile 24 volt wall or floor mounted electromagnetic door hold opens as required to suit installation requirements. Magnetic door hold opens shall be powered from the fire alarm system.
- K. Fire/Smoke Shutter Interface: Addressable fire alarm system N.C. dry output contacts installed by this contractor shall provide a hold open signal to fire/smoke shutters and release controls provided under another Division.
- L. Fire Command Center Electric Strikes: Addressable fire alarm system N.C. dry output contacts installed by this contractor shall provide a hold locked signal to electric strikes provided under another Division.

- M. Smoke Control/HVAC Interface: Addressable fire alarm system dry output contacts installed by this Contractor shall provide equipment positive start and stop signals for Firefighters' Override, stop signals for equipment shutdown and start signals for smoke control made initiation and equipment start up to the Building Control and Automation System furnished and installed under Division 15, as applicable. Addressable control relays and inputs shall be located within 2 feet of the controlled/monitored device.

2.17 ALARM SIGNAL DEVICES:

- A. Ceiling Mounted Fire Alarm Speakers in Finished Areas: Flush mounted fire alarm speakers shall be provided.
 - 1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.
 - 2. Speakers shall have a textured white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'. Speakers shall be ceiling mounted and located as required and as located on the drawings.
- B. Ceiling Mounted Fire Alarm Speakers/Visual Signals in Finished Areas: Flush mounted fire alarm speakers with integral visual alarm signals or equal shall be provided.
 - 1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.
 - 2. Speakers shall have a textured white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.
 - 3. Speakers shall be ceiling mounted and located as required by code, and as located on the drawings.
 - 4. Visual alarm signals shall be integral with audible alarm device where shown on the drawings. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed. The word "ALERT" shall be used instead of "FIRE."
 - 5. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals.
 - 6. Visual shall be synchronized.
- C. Wall Mounted Fire Alarm Speakers/Visual Signals in Unfinished Areas: Recess/surfacemounted fire alarm speakers with integral visual signals or equal shall be provided.
 - 1. Speakers shall be listed under UL Standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers shall have built in matching transformer, field selectable multiple

power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points.

2. Speakers shall have a textured white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10'.
3. Speakers shall be wall mounted and located as required by code and as located on the Drawings.
4. Visual alarm signals shall be integral with audible alarm device where shown on the Drawings. Strobe lettering shall be oriented with lettering properly oriented with letters vertical, with strobe unit installed. The word "ALERT" shall be used instead of "FIRE."
5. Visual units shall be of the electronic flashing xenon strobe type and operate on 24 volts dc. Lights shall operate in unison with audible alarm signals and continue flashing upon silencing of alarm signals.
6. Visual shall be synchronized.

2.18 FIRE ALARM POWER BOOSTERS:

- A. Provide power boosters as required. Power to be provided from emergency panel located on each floor in mechanical or electrical rooms.

2.19 SYSTEM WIRING:

- A. The equipment supplier shall furnish to the installing contractor a complete detailed point-to-point wiring diagram showing the system equipment and required number, type and sizes of conductors and conduit sizes. Where common devices which break the alarm circuit are installed on a common zone with shorting type device, the circuit breaking devices shall be wired electrically downstream of the shorting type devices.
- B. All fire alarm system wiring shall be multi-conductor, UL listed FPL for limited energy (300 volt) and fire alarm applications, and NEC approved fire alarm cable. Wiring shall be installed in accordance with NEC, local codes, Article 760 of NFPA Standard 70, and manufacturer's recommendations. All wiring shall be copper and installed in conduit sized in accordance with the National Electrical Codes.
- C. Fire alarm system wiring shall be color coded.
- D. All fire alarm system junction boxes including covers, shall be secured, painted red and marked in contrasting lettering.
- E. Wire size shall be determined by calculated voltage drop and circuit loading. Minimum wire size shall be as follows:
 1. #18 AWG for initiating and low voltage auxiliary control circuits.
 2. #16 AWG for alarm circuits.
 3. #14 AWG for all power circuits.

PART 3 EXECUTION

3.1 INSPECTION:

- A. Installer shall examine the areas and conditions under which the fire alarm system is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 SYSTEM DESIGN:

- A. General: The basic equipment and device locations have been shown on the contract drawings. Specific wiring between equipment/devices has not been shown. It is the contractor's responsibility to submit for approval the COMPLETE ENGINEERED system configuration and layout showing all devices, wiring, conduit, and locations along with other required information as specified herein.

3.3 PROGRAMMING:

- A. General: The manufacturer shall provide and install a menu driven software package, and shall provide all required programming of the system, including digitized voice alarms, graphics and action messages. Map and report formatting will be part of the software package. The software programming shall provide clear decision-making displays and text during critical alarm conditions that will allow the operator to make simple decisions during a crisis.
- B. Review: Before the manufacturer loads the program the Owner shall be given the opportunity to review and approve all textural displays, messages and system sequences.

3.4 INSTALLATION:

- A. General: Install system and materials in accordance with manufacturer's instructions, roughing-in drawings, and details on the Drawings. Install electrical work and use electrical products complying with the requirements of the applicable Division 16 sections of these Specifications. Mount manual stations and alarm devices at heights specified in NFPA 72.
- B. Wiring: All wiring shall be in accordance with NFPA 72, the National Electrical Code, Local Codes, and Article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.
 - 1. Install fire alarm system line voltage and low-voltage wiring in a suitable raceway. Conceal fire alarm system wiring in conduit in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.
 - 2. All wiring shall be run in a supervised fashion (i.e. no branch wiring or doglegged wiring) per NFPA requirements such that any wiring disarrangement will initiate the appropriate trouble signals via the main control panel per NFPA and UL requirements. Intelligent SLC loops may be T-tapped/branch wired due to inherent dynamic supervision.
 - 3. Wiring splices shall be kept to a minimum with required splices to be made in designated terminal boxes or at field device junction boxes. Transposing or color code changes of wiring will not be permitted. End-of-line supervisory devices shall be installed with the last device on the respective circuit. Said device shall be appropriately marked designating it as the terminating device on the respective circuit.
 - 4. No AC wiring or any other wiring shall be run in the same conduit as fire alarm wiring.

5. Number code and color code conductors appropriately and permanently for future identification and servicing of the system.
- C. Conduit/Raceway: All wire shall be required to be installed in an approved conduit/raceway system (except where excluded by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
1. Conduit and raceway system shall be installed, where required, as specified other Sections of the Specifications.
 2. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
 3. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/ conduit system. All riser boxes shall be adequately sized for the number of conductors traversing the respective box as well as the number of terminations required. All vertical risers shall be installed in 2 hour rated chases.
- D. Labeling: All system controls, indicators and other devices shall be labeled with names, designations and operating instructions as applicable. Labels shall be either engraved nameplates or covered printed labels and shall be approved by the Engineer. All water flow switches which are hidden shall have identification points. These identification points shall be red tags with white lettering indicating location of the water flow switch. Tag location will be visible from corridors.
- E. Checkout: Check wiring to ensure that wiring is in accordance with the system manufacturer's wiring diagrams and that the system is free of open circuits, short circuits, and grounds.
- F. Identification: Refer to for additional requirements concerning painting, nameplates, and labeling.

3.5 COORDINATION:

- A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all trades. Adequate coordination shall be provided to ensure proper installation and interface to all peripheral items required to interact with the fire alarm to provide a complete and functional life safety system.
- B. The installing contractor shall be fully responsible for coordinating all system and device messages and system operation with the Owner's Representatives and Operating Personnel.

3.6 SYSTEM CHECKOUT AND TEST:

- A. All final control panel connections shall be made by a state licensed, factory-trained technical representative of the manufacturer and who shall supervise a System Checkout and Test to demonstrate and confirm to the Engineer, and Owner's Representative that the fire alarm system is 100% operational upon completion of the installation, and that it complies with all local code requirements and these specifications. It is intended that the System Checkout and Test be followed by a continuing program of inspection testing and maintenance. The Contractor shall provide a proposal to the Owner for a Maintenance, Inspection and Quarterly Testing Contract in compliance with NFPA 72, upon completion and system checkout.
- B. The System Checkout and Test shall be performed within 30 days after the fire alarm installation and all peripheral systems are completed. The System Checkout and Test shall be performed by a minimum of two licensed fire alarm system technicians, one of which is licensed

by the State of Maryland, and acceptable to the Engineer and the authority having jurisdiction. The test shall be performed in two parts and two-way radios for use by the test observers shall be provided. The first part shall be a full dry-run test with all subcontractors present, but without the Owner's Representative or fire department present. After the dry-run test is successfully completed, then the final test with the Owner's Representative present shall be performed.

- C. This Contractor shall coordinate the test schedule with all necessary parties and subcontractors required to be present for a complete and functional test.
- D. The System Checkout and Test which is a comprehensive 100% inspection and test of all fire alarm system equipment and shall include, but not be limited to the following:
 1. Fire Alarm Control Equipment:
 - a. A visual and functional test of all fire alarm control and auxiliary control equipment.
 - b. A visual inspection shall be conducted to establish that all electrical connections and equipment as required are properly installed and operating.
 - c. A remote functional fault simulation test shall be conducted on all relevant field wiring terminations to ensure that all wiring is properly supervised as required.
 - d. All indicators shall be tested to ensure proper function and operation.
 - e. All device messages shall be verified to be correct, as installed.
 - f. All system auxiliary functions including, but not limited to, CPU reporting, elevator recall, fire/ smoke door and shutter control, security interface, HVAC equipment control and shutdown, smoke control initiation, and other specified control functions shall be functionally tested to verify proper operation and proper system messages.
 - g. Control panel supervisory and alarm current readings shall be taken to verify that the control panel has the appropriate power supplies and standby batteries to operate the system as required. A 3 minute general alarm stress test both under ac power and standby power shall be conducted to further ensure complete operation of the system.
 - h. The firefighters' HVAC system override panel shall be 100% functionally tested to verify that all control switches and indicators function as specified.
 2. Fire Alarm Peripheral Devices: All fire alarm peripheral devices shall be functionally tested and the location and testing information recorded for each device.
 3. Initiating Devices (Manual and Automatic): All manual and automatic initiating devices shall be inspected to ensure proper placement and mounting as recommended by the manufacturer and as indicated in these specifications.
 - a. All manual fire alarm stations and all automatic initiating devices (smoke detectors, heat detectors, water flow switches, etc.) shall be functionally tested for alarm operation.
 - b. A minimum of 10% of initiating devices shall be functionally tested for proper wiring supervision. Failure of any tested device on any zone shall require that all devices in that zone shall be tested for supervision.

c. All device messages shall be verified to be correct as installed.

4. Alarm Signaling Devices:

- a. All visual alarm indicators and exit sign flashing shall be functionally tested to ensure proper operation and that they are clearly visible.
- b. Alarm signaling devices shall be field-checked and tested for proper operation and output.
- c. A minimum of 10% of the alarm signaling device shall be functionally tested for proper wiring supervision.

5. Reporting:

- a. Upon completion of the 100% System Checkout and Test, four copies of the final report shall be documented, certified, and sent to the Engineer for distribution to the Owner or authorized Owner's Representative indicating that all fire alarm equipment has been tested and is 100% operational.
- b. The final report shall be generated by the equipment manufacturers headquarters or authorized representative to ensure integrity and uniformity of all testing procedures and reporting. The report shall contain the testing information, stating the precise location and operational status of each and every peripheral device and shall include a Fire Alarm System Certification and Description Document per NFPA 72.
- c. The 100% System Checkout and Test shall be performed by factory trained representatives, and one of the individuals shall possess a state license for fire alarm installation supervision.
- d. Upon satisfactory system checkout, the fire alarm system shall be labeled with the appropriate Baltimore City fire alarm labels.

3.7 TRAINING:

- A. Upon completion of the installation, the equipment manufacturer shall furnish his services for a period of 8 hours of demonstration and training in the use of the system and its connected equipment. The 8 hour training period shall consist of operations and trouble shooting and technical trouble shooting of the fire alarm panel and system. All training shall be provided at the site.

3.8 AS-BUILT/RECORD DRAWINGS:

- A. Two sets of manuals and as-built drawings shall be provided by the Contractor. The as-built drawings shall include a reproducible drawing and two copies of each as-built drawing. The drawings and manuals shall be used in the training sessions. At this time, manuals describing the system equipment, as-built wiring diagrams, system keys, and certification of a 100% system audit will be delivered to the Owner. Record drawings shall include, but not be limited to:
 - 1. As-built wiring and conduit layout diagrams incorporating wire color code and/or label numbers and showing all interconnections in the system.

2. Actual locations of each input and output circuit termination, the identification marking of each circuit and the address of each device. Provide an input/output assignment chart. A unique identification number shall be assigned to each alarm initiating device. Identification should be by zone number permanently mounted adjacent to the device or its mounting base. Markings with felt tip pens will not be acceptable.
 3. As-built schematic wiring diagrams of all control panels, modules, annunciators and communications panels.
 4. As-built heat and smoke detector location drawings showing location dimension of each detector and alarm box.
 5. Copies of the manufacturers technical literature on all major parts of the system including detectors, manual stations, signaling appliances, alarm panels. communication panels and equipment and power supplies.
 6. Completed Fire Alarm System Certification and Description Document.
- B. Refer to Section for additional As-Built/Record Drawings requirements.

3.8 OPERATING AND MAINTENANCE DATA:

- A. The manufacturer's authorized representative shall instruct the Owner's designated employees in the proper operation of the system and all required periodic maintenance. This instruction will include three copies of a written summary in booklet or binder form so employees can retain for future reference. Basic operating instructions for the system shall be framed and mounted at the main control unit.

3.9 REFER TO SECTION 26 00 01 FOR ADDITIONAL REQUIREMENTS.

3.10 WARRANTY:

- A. The fire alarm and security systems shall be warranted against defects in workmanship and materials, under normal use and service, for a period of 2 years from the date of acceptance by the Owner. Any equipment shown to be defective shall be repaired, replaced or adjusted free of charge.
- B. The warranty period shall begin after successful completion of the Owner's inspections and tests. In the event of any system malfunctions or nuisance alarms, the Contractor will take appropriate corrective action. This action may necessitate a repeat of the response test if the Owner so desires. Continued improper performance during warranty shall be cause to require the Contractor to remove the system.
- C. The warranty start date will not begin until after a period of 30 consecutive days of system operation without any nuisance alarms caused by malfunctioning of hardware or software.

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

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. Protecting existing vegetation to remain.
2. Clearing and grubbing.
3. Temporary erosion- and sedimentation-control measures.

- B. Related Sections:

1. Division 01 Section "Temporary Facilities" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Division 01 Section "Construction Waste Management and Disposal", for demolition of buildings, structures, and site improvements.
3. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling and site grading.
4. Division 32 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt and clay particles; friable and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
- B. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
- C. Critical Root Zone: As a distance of three feet equal distance from the trunk, for each inch of trunk diameter.

1.4 MATERIAL OWNERSHIP

- A. Except for materials indicated to remain on Owner's property, or to be salvaged per the Owner's Salvage List; cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Pre-clearing photograph or videotape, sufficiently detailed, of existing trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record Drawings, according to Division 01 Section "Project Record Documents," identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01.
 - 1. Identify and accurately locate utilities and other substructure structural, electrical and mechanical conditions.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct roads, walks, or other adjacent occupied or used facilities without permission from Owner.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- C. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- D. Do not direct vehicle or equipment exhaust towards tree protection zones.
- E. Prohibit heat sources, flames, ignition sources and smoking within or near tree protection zones.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
 - 1. Obtain approved borrow soil material off-site, or utilize on-site borrow material deemed approved satisfactory soil per the geotechnical engineer. Retain paragraph below if needed for cut ends of steel reinforcement in concrete to remain; revise to suit Project.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Insert specific procedures or installation requirements for temporary soil protection and stabilization, erosion controls, stormwater runoff controls, and sedimentation controls. If particular products are required, add product standards and descriptions to Part 2.
- B. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to Maryland Department of Environment (MDE) approved erosion- and sedimentation-control drawings.
- C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree protection zones.
- D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 UTILITIES

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than 72 hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions and other vegetation to permit installation of new construction as indicated on the Site Plan.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.
- 2.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove all excavated material, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 311005 – SITE DEMOLITION

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. This Section includes the following:

1. Vegetation Clearing and grubbing.
2. Removing above grade site components
3. Salvage materials and return to Owner as indicated on Drawings

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

1. Division 1 Section "Tree Protection" for vegetation protective measures
2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading.
3. Division 31 Section "Site Clearing" for site clearing.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 01 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earthwork."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 VEGETATION CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction as shown on drawings. Use trees for habitat deadfall amenities.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.3 SITE COMPONENTS

A. Remove existing above improvements as indicated and as necessary to facilitate new construction.

B. Remove paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3. Remove existing clay brick pavers, clean and stockpile for reusing in brick restoration

3.4 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

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SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for walks, pavements and lawns and grasses.
 - 2. Excavating and backfilling for structures.
 - 3. Subbase course for concrete walks and pavement.
 - 4. Subbase and base course for paving.
 - 5. Excavating and backfilling for utility trenches.
 - 6. Excavating and backfilling trenches for buried utilities and pits for buried utility structures.
- B. Related Sections include the following:
 - 1. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
 - 2. Division 32 Section "Turf and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.
 - 3. Divisions 26 and 16 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

1.3 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil (Select Borrow) imported from off-site for use as fill or backfill.
- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations.

1. Authorized Additional Excavation: Excavation below subgrade elevations as directed by the Geotechnical Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
 2. Bulk Excavation: Excavation more than **10 feet** in width and more than **30 feet** in length.
 3. Unauthorized Excavation: Excavation below subgrade elevations without direction by the Geotechnical Engineer. Unauthorized excavation, as well as remedial work directed by the Geotechnical Engineer, shall be without additional compensation.
- G. Fill: Soil materials approved by the Geotechnical Engineer to be used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed **1 cu. yd.** for bulk excavation or **3/4 cu. yd.** for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Excavation of Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a **42-inch-wide**, maximum, short-tip-radius rock bucket; rated at not less than **138-hp** flywheel power with bucket-curling force of not less than **28,090 lbf** and stick-crowd force of not less than **18,650 lbf**; measured according to SAE J-1179.
 2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than **210-hp** flywheel power and developing a minimum of **48,510-lbf** breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- I. Structures: Buildings, footings, retaining walls, slabs, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- 1.4 SUBMITTALS
- A. Product Data: For the following:
1. Each type of detectable warning tape.
- B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
1. Classification according to ASTM D 2487 of each borrow soil material proposed for fill and backfill.
 2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

- C. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials, rock-definition testing, and verification of the presence of contaminate materials, as documented according to ASTM D 3740 and ASTM E 548.
- B. Contractor shall follow all OSHA requirements and all local, State and Federal regulations for soil excavation.
- C. Pre-excavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Owner not less than 72 hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
 - 4. Verify existing utility services for area where Project is located before excavation.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Refer to Section 916 of SHA Standard Specifications for Construction and Materials.
- B. General: Provide select borrow soil materials for replacement of all excavated material removed from the pipe trench. All excavated material deemed unsuitable by the geotechnical engineer removed from the trench excavations shall be hauled and disposed off-site. Provide test results or certification that borrow material meets the requirements for the specified material.
- C. Satisfactory Soils: Select Borrow as Per Section 916.01.01 of the MSHA Standard Specifications for Construction and Materials.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a **1-1/2-inch** sieve and not more than 12 percent passing a **No. 200** sieve per Section 901 of the MSHA Standard Specifications for Construction and Materials.

- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a **1-1/2-inch** sieve and not more than 8 percent passing a **No. 200** sieve per Section 901 of the MSHA Standard Specifications for Construction and Materials.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a **1-1/2-inch** sieve and not more than 12 percent passing a **No. 200** sieve.
- G. Bedding Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch** sieve and 0 to 5 percent passing a **No. 4** sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch** sieve and 0 to 5 percent passing a **No. 8** sieve.
- I. Topsoil: Loam, without stones or debris larger than 1/2 inch in diameter, without roots, vegetation, and without harmful materials or other debris which may be harmful to plant life. The topsoil shall contain a minimum of 5% - 8% of organic matter by weight when tested in accordance with AASHTO T 194. Other components shall be within the following percentages:
- Silt 25 – 50%
 - Clay 10 – 30 %
 - Sand 20 – 35 %
 - pH 6 – 7.0
 - Soluble Salts 500 ppm maximum
1. Topsoil shall be the deeper of either a 4" depth or as recommended by the Soil Testing Laboratory.
 2. Off-Site Topsoil: Topsoil furnished by the Contractor shall meet the requirements specified above, as tested by the Contractor and by an independent, state-operated, or university-operated laboratory recognized by the State Department of Agriculture, as noted in Specification 329200 / 329300 and approved by the Geotechnical Engineer.
 3. All type and quantity of soil amendments required shall be per Soil Testing Laboratory's recommendations in weight per 1000 sq. ft. or volume per cu. yd.
 - 4.
- J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch** sieve and 0 to 5 percent passing a **No. 4** sieve.
- K. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- M. Structural Fill: All fills placed directly below or within the zone of influence of any bearing foundation or structural slab. Structural fill material shall consist of soils meeting Unified Soil Classification System (USCS) of SM or greater (i.e. SM through GW). GC and SC materials may be utilized as compacted structural fill if they contain less than 35% passing No. 200 sieve and a maximum Plasticity Index of 15. All soil materials that fall within the USCS type OL, OH, CH, CL, MH, and ML, as well as material containing organic matter, ashes, cinders, refuse, frozen or other unsuitable materials are prohibited for use as Structural Fill. The soils classified as CL, ML; and CH/MH with a maximum Liquid Limit of 60% and Plasticity Index of 30%, can be

used as structural fills at depths greater than 4-feet below pavement subgrades and within non-structural areas.

2.2 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, **6 inches** wide and **4 mils** thick, continuously inscribed with a description of the utility, with a metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches. Color shall be as follows.
1. Red: Electric.
 2. Yellow: Gas, oil, steam and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Prepare subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface as specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls in accordance with Maryland Department of the Environment and Baltimore City requirements during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives on this project.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. Excavated materials will be hauled and disposed off-site. Fill and backfill shall be satisfactory soil materials meeting paragraph 2.1.C.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. **6 inches** beneath bottom of concrete slabs on grade.
 - b. **6 inches** beneath pipe in trenches, and the greater of **24 inches** wider than pipe or **42 inches** wide.
- B. Contaminated Soils Excavation: Soils classified as being contaminated in accordance with the Environmental Investigation Report shall be utilized as fill material in accordance with the recommendations of the Environmental Investigation report. Excess contaminated material shall be hauled off and disposed of to a safe and legal facility authorized to receive the contaminated material. Removal, handling, and disposal of contaminated material shall be without additional compensation.
 - 1. Notify the Geotechnical Engineer when excavations commence to test for the presence of contaminants.
 - 2. Provide over excavation of material to be exposed to the surface in the finished condition to a depth in accordance with the Environmental Investigation Report. Backfill over excavation with suitable material to finished grade in accordance with the Environmental Inspection Report.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to the indicated elevations and dimensions within a tolerance of plus or minus **1 inch**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Basins and Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus **1 inch**. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to **12 inches** higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: As indicated.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes. Shape subgrade to provide continuous support for bells, joints and barrels of pipes, unless otherwise indicated.
 - 1. For pipes less than **6 inches in nominal diameter, hand-excavate trench bottoms and support pipe on an undisturbed subgrade.**
 - 2. **For pipes 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.**
 - 3. **Excavate trenches 6 inches deeper** than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

- A. Notify Geotechnical Engineer when excavations have reached required subgrade.
- B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for Unit Price Items.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations by extending bottom elevation of concrete foundation to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **2500 psi**, may be used when approved by the Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by the Engineer.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials only at locations that have been approved by the Owner. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Surveying locations of underground utilities for Record Documents.
 2. Testing and inspecting underground utilities.
 3. Removing concrete formwork.
 4. Removing trash and debris.
 5. Removing temporary shoring and bracing, and sheeting.
 6. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill trenches excavated under structure and within **18 inches** of bottom of structure with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 3 Section "Cast-in-Place Concrete."
- D. After installing compacted pipe bedding material, place and compact initial backfill of satisfactory soil, free of particles larger than **1 inch** in any dimension, to a height of **12 inches** over the utility pipe or conduit.
 1. Carefully compact initial bedding material under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- E. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Install warning tape directly above utilities, **12 inches** below finished grade, except **6 inches** below subgrade under pavements and slabs. Warning tape is not required for storm drains.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than **8 inches** in loose depth for material compacted by heavy compaction equipment, and not more than **4 inches** in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under pavements, scarify and recompact top **12 inches** of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top **6 inches** below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under lawn or unpaved areas, scarify and recompact top **6 inches** below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Lawn or Unpaved Areas: Plus or minus **1/2 inch**.
 2. Walks: Plus or minus **1/4 inch**.
 3. Pavements: Plus or minus **1/4 inch**.

3.17 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
1. Place base course material over subbase course under hot-mix asphalt pavement.
 2. Shape subbase and base course to required crown elevations and cross-slope grades.
 3. Place subbase and base course **6 inches** or less in compacted thickness in a single layer.
 4. Place subbase and base course that exceeds **6 inches** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches** thick or less than **3 inches** thick.
 5. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.18 FIELD QUALITY CONTROL

- A. Testing Agency: The owner shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every **2000 sq. ft.** or less of paved area, but in no case fewer than 3 tests.
 2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each **150 feet** or less of trench length, but no fewer than 2 tests.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 312000

SECTION 312319 - DEWATERING

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 construction dewatering.
- B. Related Requirements:
 - 1. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
 - 3. Review geotechnical report.
 - 4. Review proposed site clearing and excavations.
 - 5. Review existing utilities and subsurface conditions.
 - 6. Review observation and monitoring of dewatering system.

1.4 SUBMITTALS

- A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.
 - 1. Include plans, elevations, sections, and details.
 - 2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
 - 3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 - 4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

- B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer registered in Maryland responsible for their preparation.
- C. Qualification Data: For Installer and professional engineer.
- D. Field quality-control reports.
- E. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.
- F. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of the Owner.

1.6 FIELD CONDITIONS

- A. Project-Site Information: A geotechnical report has not been prepared for this Project. Contractor shall employ a geotechnical engineer as necessary, to be approved by the owner, to render opinions and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 5. Remove dewatering system when no longer required for construction.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls, which are specified on the MDE approved plans.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
1. Space well points or wells at intervals required to provide sufficient dewatering.
 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
 - 1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
 - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

- C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- D. Prepare reports of observations.

3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

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.
- B. City of Baltimore Department of Public Works Specifications Materials, Highways, Bridges, Utilities, and Incidental Structures, 2006.

1.2 SUMMARY

- A. Section includes temporary excavation support and protection systems.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review existing utilities and subsurface conditions.
 - 2. Review coordination for interruption, shutoff, capping, and continuation of utility services.
 - 3. Review proposed excavations.
 - 4. Review proposed equipment.
 - 5. Review monitoring of excavation support and protection system.
 - 6. Review coordination with waterproofing.
 - 7. Review abandonment or removal of excavation support and protection system.

1.4 SUBMITTALS

- A. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
 - 1. Include plans, elevations, sections, and details.
 - 2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
 - 3. Indicate type and location of waterproofing.
 - 4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.
- B. Qualification Data: For Installer and Professional Engineer.
- C. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- D. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.
- E. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Architect, Owner, and Utility Owner no fewer than two days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Owner's and Utility Owner's written permission.
- B. Project-Site Information: A geotechnical report has been prepared for this Project. Contractor shall employ a geotechnical engineer as necessary, to be approved by the owner, to render opinions and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
 - 2. The geotechnical report is included elsewhere in Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Geotechnical Testing Agency: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.
- B. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
 - 1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36, ASTM A 690, or ASTM A 992.
- C. Steel Sheet Piling: ASTM A 328, ASTM A 572, or ASTM A 690; with continuous interlocks.
 1. Corners: Site-fabricated mechanical interlock.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.
- E. Tiebacks: Steel bars, ASTM A 722.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner. Provide alternate routes around closed or obstructed traffic ways if required by Owner.
- C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular

intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Drill, install, grout, and tension tiebacks.
- B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.
- C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing if required to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
- C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.7 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
- B. Fill voids immediately with approved backfill compacted to density specified in City of Baltimore Department of Public Works Specifications Materials, Highways, Bridges, Utilities, and Incidental Structures, 2006.
 - 1. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
- C. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

SECTION 321216 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt patching.
 - 3. Pavement-marking paint.
 - 4. Cold milling of existing hot-mix asphalt pavement.
- B. Related Sections include the following:
 - 1. Division 01 Section Submittal Procedures” for review methods and procedures.
 - 2. Division 31 Section “Earth Moving” for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 3. Division 32 Section “Pavement Joint Sealants” for joint sealants and fillers at paving terminations.

1.3 DEFINITIONS

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- B. DOT: Department of Transportation.

1.4 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of Maryland State Highway standard specifications.
 - 1. Standard Specification: Maryland State Highway Administration Standard Specification for Construction and Materials.

2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material Test Reports: For each paving material.
- D. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: manufacturer shall be registered with and approved by Maryland State Highway Administration.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.
- C. Regulatory Requirements: Comply with Maryland State Highway standard specifications for asphalt paving work.
- D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of **60 deg F**.
 2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
 3. Asphalt Base Course: Minimum surface temperature of **40 deg F** and rising at time of placement.
 4. Asphalt Surface Course: Minimum surface temperature of **60 deg F** at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of **50 deg F** and not exceeding **100 deg F in a 24 hour period**.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Recycled Content: Provide maximum reclaimed asphalt pavement (RAP) as feasible.
- C. Regional Content: Provide RAP manufactured and of recycled raw materials recovered within 100 mile radius of Project Site.
- D. Coarse Aggregate: In accordance with Maryland State Highway standards and specifications.
- E. Fine Aggregate: In accordance with Maryland State Highway standards and specifications.
- F. Mineral Filler: In accordance with Maryland State Highway standards and specifications.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO MP 1, PG 64-22.
- B. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.
- C. Prime Coat: Asphalt emulsion prime complying with Maryland State Highway Administration requirements.
- D. Tack Coat: ASTM D 977 or AASHTO M 140, emulsified asphalt or ASTM D 2397 or AASHTO M 208, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

- E. Undersealing Asphalt: ASTM D 3141 or AASHTO M 238, pumping consistency.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- C. Pavement-Marking Paint: See Section 321723 "Pavement Markings"

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by Maryland State Highway Administration; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: Superpave 19.0 mm.
 - 3. Surface Course: Superpave 9.5 mm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 1. Mill to a depth of as indicated on plans.
 - 2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
 - 3. Control rate of milling to prevent tearing of existing asphalt course.
 - 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.

5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending **12 inches** into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of **0.05 to 0.15 gal./sq. yd.**
 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surfaces.

3.4 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than **1 inch** in existing pavements.
 1. Install leveling wedges in compacted lifts not exceeding **3 inches** thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of **1/4 inch**.
 1. Clean cracks and joints in existing hot-mix asphalt pavement.
 2. Use hot-applied joint sealant to seal cracks and joints more than **1/4 inch** wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

- A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

- B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
 - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- D. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of **0.15 to 0.50 gal./sq. yd.** Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure for 72 hours minimum.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of **0.05 to 0.15 gal./sq. yd.**
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PAVING GEOTEXTILE INSTALLATION

- A. Apply tack coat uniformly to existing pavement surfaces at a rate of **0.20 to 0.30 gal./sq. yd.**
- B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints **4 inches** and transverse joints **6 inches**.
 - 1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.7 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Spread mix at minimum temperature of **250 deg F**.
 - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than **8 feet** wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of **6 inches**.
 - 3. Offset transverse joints, in successive courses, a minimum of **24 inches**.
 - 4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to **185 deg F**.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus **1/2 inch**.
 - 2. Surface Course: Plus **1/4 inch**, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a **10-foot** straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: **1/8 inch**.
 - 2. Surface Course: **1/8 inch**.

3.11 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Prime asphalt surfaces with sealer, as recommended by thermoplastic material manufacturer based on surface conditions. Include adhesive or adhesion promoter when asphaltic surfaces exhibit polished aggregate.

- E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of **15 mils**.
 - 1. Broadcast glass beads uniformly into wet markings at a rate of 6 lb / gal.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every **1000 sq. yd.** or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 DISPOSAL

- A. All excavated and demolished material shall be removed from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 321313 – CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Curbs
 - 2. Driveway Apron
 - 3. Sidewalks
- B. Related Sections include the following:
 - 1. Section 312000 "Earth Moving" for subgrade preparation, grading, and subbase course.
 - 2. Section 321373 "Pavement Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. LEED Submittals: Comply with Section 018113.
 - 1. MR Credit 2: Environmental Product Declarations
 - a. Cement, slag, steel reinforcement
 - 2. MR Credit 3: Sourcing of Raw Materials

- a. Recycled content: Slag, steel
 - b. Regionally sourced recycled content: Slag
 - 3. MR Credit 4: Material Ingredients
 - a. Report: Concrete curing compounds and sealers
 - C. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - D. Qualification Data: For manufacturer.
 - E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
 - F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Curing compounds.
 - 5. Joint fillers.
 - G. Field quality-control test reports.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 - B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
 - D. Concrete Testing Service: Contractor will engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
 - E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from one manufacturer.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Steel Reinforcement: Deliver, store and handle steel reinforcement to prevent bending and damage.
- 1.7 PROJECT CONDITIONS
- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
 - B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of **50 deg F** and not exceeding **100 deg F in a 24 hour period**.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves with a radius **100 feet** or less.
- B. 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.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Steel Bars: ASTM A 615, **Grade 60**, deformed billet steel bars, unfinished.
 - 1. Recycled Content: Provide steel with minimum 90 percent total recycled content, including at least 60 percent post-consumer recycled content.
- B. Plain Steel Wire: ANSI/ASTM A82, unfinished.
- C. Welded Steel Wire Fabric: ASTM A185 in flat sheets galvanized.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I, white. Supplement with the following:
 - a. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: **1-1/2 inches** nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
 - 3. Regional Materials: Provide aggregate manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.
- C. Solar Reflectance Index (SRI) of Concrete Paving: Minimum value of 29.

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 to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494, Type A.
 - 2. Retarding Admixture: ASTM C 494, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

2.6 CURING MATERIALS

- A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- B. Water: Potable.
- C. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following, or approved equal:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edeco; BurkeFilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, ChemRex Inc.; Confilm.
 - k. Meadows, W. R., Inc.; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. Symons Corporation; Finishing Aid.
 - p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

- D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following, or approved equal:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Burke by Edoko; Aqua Resin Cure.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - f. Euclid Chemical Company (The); Kurez DR VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; Aqua Kure-Clear.
 - i. L&M Construction Chemicals, Inc.; L&M Cure R.
 - j. Meadows, W. R., Inc.; 1100 Clear.
 - k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
 - l. Symons Corporation; Resi-Chem Clear.
 - m. Tamms Industries Inc.; Horncure WB 30.
 - n. Unitex; Hydro Cure 309.
 - o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.8 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
 1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): **4500 psi** for driveways. (3500 psi. other)
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 3. Slump Limit: **4 inches**, plus or minus **1 inch**. Slump may not be 2" or less.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 5-1/2 percent plus or minus 1.5 percent for **1-1/2-inch** nominal maximum aggregate size.
 2. Air Content: 6 percent plus or minus 1.5 percent for **1-inch** nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing 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 required to be watertight and concrete with a water-cementitious materials ratio below 0.50.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. as follows:
- G.
1. Ground Granulated Blast-Furnace Slag: 50 percent.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between **85 deg F** and **90 deg F**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F**, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Construct forms tight enough to prevent loss of concrete mortar.
- C. Clean forms and adjacent surfaces to receive concrete.
- D. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, to ensure separation from concrete without damage.
- E. Clean and repair surfaces of forms to be reused in the Work.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- 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.

- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 2. Provide tie bars at sides of pavement strips where indicated.
 - 3. Butt Joints: Use bonding agent or epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least **1-1/2 inches** into concrete.
 - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of **50 feet**, unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than **1/2 inch** or more than **1 inch** below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:
1. 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 developing random contraction cracks.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a **1/4-inch** radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- I. 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 air temperature has fallen to or is expected to fall below **40 deg F**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F** and not more than **80 deg F** at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- J. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 1. Cool ingredients before mixing to 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. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 CONCRETE FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch** deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION 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 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. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound as follows:
 - 1. 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.

3.9 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least one month or as recommended by manufacturer, whichever is longer. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds and sealers from joints; leave contact faces of joint clean and dry.

3.10 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation: **1/4 inch.**
 - 2. Thickness: Plus **3/8 inch**, minus **1/4 inch.**
 - 3. Surface: Gap below **10-foot-** long, unlevelled straightedge not to exceed **1/4 inch.**
 - 4. Lateral Alignment and Spacing of Tie Bars and Dowels: **1 inch.**
 - 5. Vertical Alignment of Tie Bars and Dowels: **1/4 inch.**
 - 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: **1/2 inch.**

7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge:
Length of dowel **1/4 inch per 12 inches**.
8. Joint Spacing: **3 inches**.
9. Contraction Joint Depth: Plus **1/4 inch**, no minus.
10. Joint Width: Plus **1/8 inch**, no minus.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least 1 composite sample for each **100 cu. yd.** or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is **40 deg F** and below and when **80 deg F** and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than **500 psi**.
- D. Test results shall be reported in writing to A/E, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project

identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by A/E but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by A/E.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Drill test cores, where directed by A/E, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

New Red Panda Exhibit
Maryland Zoo in Baltimore

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. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete and masonry pavement.
 - 2. Joints between cement concrete and asphalt pavement.
- B. Related Sections include the following:
 - 1. Section 321216 "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
 - 2. Section 321313 "Concrete Paving" for constructing joints in concrete pavement.
 - 3. Section 321400 "Unit Paving" for constructing joints in brick pavement.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Pavement-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.
- C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.

2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Submit not fewer than three pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
- D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in Division 1 "Submittal Procedures" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the commencement of the Work.
1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

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 multi-component materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. 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 or covered with frost.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

- A. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

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.
- B. 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.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior 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 onto adjoining surfaces.

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.
- 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. Install backer materials 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.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealants from surfaces adjacent to joint.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 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 and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 321723 - PAVEMENT MARKINGS

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.
- B. All work and materials shall be in accordance with Baltimore City Specifications and Details, latest edition.

1.2 SUMMARY

- A. Section includes painted markings applied to asphalt and concrete pavement.
- B. Related Requirements:
 - 1. Section 321216 "Asphalt Paving" for placement of asphalt pavement surfaces.
 - 2. Section 321313 "Concrete Paving" for placement of concrete pavement surfaces.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to marking pavement including, but not limited to, the following:
 - a. Pavement aging period before application of pavement markings.
 - b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
- B. Shop Drawings: For pavement markings.
 - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
 - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches square.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MDSHA and Baltimore City for pavement-marking work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials 55 deg F for water-based materials, and not exceeding 95 deg F .

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Aexcel Inc.
 - 2. Benjamin Moore & Co.
 - 3. Color Wheel Paints & Coatings.
 - 4. Columbia Paint & Coatings.
 - 5. Conco Paints.
 - 6. Coronado Paint; Division of INSL-X Products Corporation.
 - 7. Diamond Vogel Paints.
 - 8. Dunn-Edwards Corporation.
 - 9. Ennis Traffic Safety Solutions, Inc.
 - 10. Frazee Paint.
 - 11. General Paint.
 - 12. Kwal Paint.
 - 13. M.A.B. Paints.
 - 14. McCormick Paints.
 - 15. Miller Paint.
 - 16. Parker Paint Mfg. Co. Inc.
 - 17. PPG Industries.
 - 18. Pratt & Lambert.
 - 19. Rodda Paint Co.
 - 20. Rohm and Haas Company; a subsidiary of The Dow Chemical Company.
 - 21. Scott Paint Company.
 - 22. Sherwin-Williams Company (The).

2.2 PAVEMENT-MARKING PAINT

- A. General Requirements: Thermoplastic pavement marking material Type B for use on either asphaltic or Portland cement concrete surfaces. Clearly mark each container to indicate color, weight, type of material, and lot or batch number (consider lot or batch as each individual mix or blend that produces finished product ready for use). Package material in either suitable corrugated containers or thermal degradable plastic bags to avoid sticking during shipment or storage.
- B. Thermoplastic markings shall not be slippery when wet, nor exhibit tacky, exposed surface. Cold ductility of material shall permit normal road surface expansion and contraction without chipping or cracking. Markings shall retain their original color, dimensions, and placement under normal traffic conditions at road surface temperatures of 158 F and below.
 - 1. Color: White, handicapped blue, yellow.
 - 2. Used for parking lot striping, symbols, roadway lane striping, fire lane striping, crosswalk striping, and stop bars.
- C. Prime and filler pigments shall pass U.S. Standard sieve No. 230 (0.0024 inch opening) when washed free of resins by solvent washing, and meet following specific requirements for each pigment.
 - 1. Prime Pigments: White pigment shall be Rutile Titanium Dioxide.
 - 2. Filler Pigment: Filler pigment shall be calcium carbonate, 95% purity.
- D. Binder
 - 1. Type B - Alkyd: Use binder consisting of mixture of resins, at least one of which is solid at room temperature, and high boiling point plasticizers. At least one-third of binder compositions shall be a maleic-modified glyceryl ester 012 Rosin and shall be no less than 8% by weight of entire material formulation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions. Clean pavement by sandblasting and prepare in accordance with recommendations of thermoplastic material manufacturer and to satisfaction of Engineer, prior to placement of markings. Surface scarification can be used with prior approval of Engineer.
- B. Prime asphaltic surfaces with sealer, as recommended by thermoplastic material manufacturer based on surface conditions. Include adhesive or adhesion promoter when asphaltic surfaces exhibit polished aggregate.
- C. Proceed with pavement marking only after unsatisfactory conditions have been corrected.
- D. Spray apply pavement marking or extrude hot to pavement surface unless application method is specified on Drawings.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Use crew experienced in work of installing pavement markings and supply all equipment and materials necessary for placement of pavement markings.
- E. Apply material within temperature limits recommended by manufacturer.
- F. Prior to placement of thermoplastic material, properly prepare pavement with primer.
- G. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
 - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.
- H. Provide continuous mixing and agitation of material. Provide clean, square, marking ends. Do not use pans, aprons, or similar appliances which dye overruns.
- I. Provide thermometer capable of measuring temperature of pavement marking material.
- J. Use automatic bead dispenser attached to pavement marking equipment in manner that materials are dispensed uniformly and almost instantly upon marking as marking is being applied to road surface. Rate of application shall be sufficient to achieve characteristics specified. Provide automatic cut-off control for bead dispenser, synchronized with cut-off of pavement marking equipment.
- K. Place markings in accordance with approved site plan so that minimal interruption to traffic flow is achieved. Protect newly-installed pavement markings from damage by traffic.
- L. Apply pavement markings onto clean, dry pavement having road surface temperature above 60 F for Portland cement concrete surface and above 50 F for asphaltic surface. When pavement marking application is by spray and operations cease for five or more minutes, flush spray head by spraying pavement marking material into pan or similar container until material is proper temperature for application.
- M. Material shall not prohibit adhesion of other thermoplastic markings if, at some future time, new markings are placed over existing materials.
- N. Maintain uniform thickness of each pavement marking. Minimum thickness of markings, as measured above plane formed by pavement surface, shall not be less than 1/8 inch (125mils), unless shown otherwise on Drawings. Maximum thickness shall be 3/16 inch. Supply device, approved by Engineer, to measure thickness of applied extruded marking

- O. Use markings that are completely reflectorized internally and externally.

3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 323113 – CHAIN-LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All work and materials shall be in accordance with Baltimore City Specifications and Details, latest edition.

1.2 SUMMARY

- A. The work in this section shall consist of refurbishing and installing new chain link fencing as shown on the Contract Drawings and as specified herein.
- B. This Section includes the following:
 - 1. Galvanized Steel Chain-Link Fabric.
 - 2. Galvanized Steel Framework.
- C. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for site excavation, fill, and backfill where chain-link fences are located.
 - 2. Division 3 Section "Cast-In-Place Concrete" for concrete post concrete fill.

1.3 DEFINITIONS

- A. CLFMI: Chain Link Fence Manufacturers Institute.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences.
 - 1. Fence posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
 - 3. Privacy Slats.
- B. Shop Drawings: Show locations of fences, posts, rails, tension wires, details of extended posts, extension arms, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components.
- C. Product Certificates: For each type of chain-link fence, signed by product manufacturer.

1. Strength test results for framing according to ASTM F 1043.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

F. LEED Submittals.

1. Product data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Chain-Link Fences: Obtain each grade, finish, type, and variety of component for chain-link fences from one source with resources to provide chain-link fences of consistent quality in appearance and physical properties.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

B. Interruption of Existing Utility Service: Do not interrupt utility services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner and Architect no fewer than two days in advance of proposed interruption of utility services.
2. Do not proceed with interruption of utility services without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chain-Link Fences:

- a. Allied Tube & Conduit Corp., Harvey, IL
- b. American Chain Link Fence Co., Medford, MA
- c. Anchor Fence, Inc., Baltimore, MD
- d. Long Fence, Baltimore, MD
- e. Page-Wilson Corp., Monessen, PA

- f. Security Fence Mfg. & Supply Co., Bladensburg, MD
- g. Sonco Fence Mfg. Company, Bladensburg, MD, or equal.

2.2 CHAIN-LINK FENCE FABRIC

- A. Steel Chain-Link Fence Fabric: Height indicated on Drawings. Provide fabric in one-piece widths for fencing in height of 12 feet and less. Comply with CLFMI CLF 2445 and requirements indicated below:
 - 1. Mesh and Wire Size: 1-inch mesh, 9 ga. Diameter with minimum breaking strength of 1,290 pounds The steel core wire shall be galvanized in accordance with ASTM A-641-71A. Fabric shall be knuckled at top and bottom.
 - 2. Zinc-Coated Fabric: ASTM F-668, Type 2B with zinc coating (Aluminized) applied after weaving.
 - a. Fabric shall be thermally fused vinyl coated steel chain link fabric furnished in accordance with ASTM F-668, Type 2B. The color shall be black.
 - b. Thickness of vinyl coating shall be 10-14 mills applied by fusion bonding.

2.3 INDUSTRIAL FENCE FRAMING

- A. Round Steel Pipe: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe. Comply with ASTM F 1043, Material Design Group 1A, external and internal coating Type A, consisting of not less than 1.8-oz./sq. ft. zinc, and the following:
 - 1. Group: IA, round galvanized steel pipe, Schedule 40 minimum, powder coated black.
 - 2. Strength Requirement: Light industrial according to ASTM F 1043.
 - 3. Post Diameter and Thickness: According to ASTM F 1043.
 - 4. Post Size and Thickness: According to ASTM F 1043.
- B. Post Brace Rails: Match top rail for coating and strength and stiffness requirements. Provide brace rail with truss rod assembly for each end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.
- C. Top Rails: Fabricate top rail from lengths 21 feet or longer, with swaged-end or fabricated for expansion-type coupling, forming a continuous rail along top of chain-link fabric.
- D. Intermediate Rails: Match top rail for coating and strength and stiffness requirements.

2.4 FITTINGS

- A. General: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626. All fittings to be powder coated black.
- B. Post and Line Caps: Permanently attached, hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide a weathertight closure cap for each post. Where top rail is to be installed, provide a cap with a hole suitable for the through passage on of the rail.

1. Line post caps with loop to receive tension wire or top rail.
 - C. Rail and Brace Ends: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide rail ends or other means for attaching rails securely to each corner, pull, and end post.
 - D. Rail Fittings: Provide the following:
 1. Top Rail Sleeves: Hot-dip galvanized pressed-steel or round-steel tubing not less than 6 inches long.
 2. Rail Clamps: Hot-dip galvanized pressed steel. Provide line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.
 - E. Tension and Brace Bands: Hot-dip galvanized pressed steel. Where pipe posts are used, vinyl coated tension bands shall be used, fastened to posts with vinyl coated bands at intervals not to exceed 15". Attachment bolts for bands shall be 5/16" 1-1/2"galvanized carriage bolts with nuts. Bolts and nuts shall be field painted to match vinyl color. One tension bar shall be provided for each end and gate post and two for each corner and pull post. Tension Bars: Hot-dip galvanized steel, length not less than **2 inches** shorter than full height of chain-link fabric. Provide one bar for each end post, and two for each corner and pull post, unless fabric is integrally woven into post.
 - F. Truss Rod Assemblies: Hot-dip galvanized steel rod and turnbuckle or other means of adjustment.
 - G. Tie Wires, Clips, and Fasteners: Provide the following according to ASTM F 626:
 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: 0.106-inch- diameter wire; galvanized thickness matching coating thickness of chain-link fence fabric.
 - H. Round Wire Clips: Hot-dip galvanized steel for attaching chain-link fabric to H-beam posts.
 - I. Round Wire Hog Rings: Hot-dip galvanized steel or aluminum for attaching chain-link fabric to horizontal tension wires.
- 2.5 PRIVACY SLATS
- A. Material: Polyethylene tubular slats, not less than 0.023 inch thick, manufactured for chain-link fences from virgin polyethylene containing UV inhibitor, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips.
 - B. Color: Provide full selection of color options in fence submittal.
- 2.6 CAST-IN-PLACE CONCRETE
- A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water. Measure, batch, and mix Project-site-mixed concrete according to ASTM C 94/C 94M.

1. Concrete Mixes: Normal-weight concrete with not less than 3500-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.
- B. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to manufacturer's written instructions.

2.7 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.
 1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.
 1. Install fencing as shown on construction drawings.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil.

- B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil to a depth approximately 6" deeper than post bottom. Excavate deeper, as required, for adequate support in soft and loose soils. Set posts in concrete footing. See Contract Drawings for additional details.
1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 2. Concrete Fill: Place concrete around posts in a continuous pour. Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Trowel finish tops of footings and slope or dome to direct water away from posts.
 - b. Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
- C. Terminal Posts: Locate terminal end, corner, and post per ASTM F 567 and terminal pull posts as indicated on plans and at changes in horizontal or vertical alignment of 30 degrees or more. Install with tops properly aligned.
- D. Line Posts: Space line posts at equal intervals, 8 feet o.c. maximum.
- E. Post Bracing, Intermediate and Bottom Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end posts and at both sides of corner and pull posts.
1. On all fencing greater than 6' in height, locate horizontal braces at mid-height of fabric on fences with top rail and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
 2. Install bottom rail spanning between posts and not less than four inches (4") above the level of finished grade.
- F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.
1. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same gage and type of wire.
- G. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Stretch and attach chain link fence fabric. See drawings for type of fence fabric. Leave 2 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and posts with tension bands spaced not more than 15 inches o.c.

- I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at 1 end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 PRIVACY SLATS

- A. Privacy Slats: Install slats in direction indicated as recommended by manufacturer, securely locked in place.
 - 1. Diagonally, for privacy factor of 90.

END OF SECTION 323113

SECTION 323113 – FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. PVC-coated steel Exclusion Fencing and Gates.
 - 2. Galvanized steel with composite lumber View Rails and Gates
 - 3. Galvanized steel with boma wood panels Fencing and Gates
- B. Related Sections:
 - 1. Division 3 – Cast in Place Concrete- concrete footers
 - 2. Division 9 – Exterior Painting

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, and details of post anchorage and attachment and bracing.
- C. Samples:
 - 1. PVC-coated steel wire for fabric and polymer coating on framing and accessories.
 - 2. Galvanized steel frame section
 - 3. Composite wood
 - 4. Eucalyptus 1" diameter section

PART 2 - PRODUCTS

2.1 EXCLUSION FENCE & GATE FRAMING

- A. PVC Coated, Round Posts and Frames : ASTM F 761.
 - 1. Fence Height: as shown on drawings
 - 2. Line, End, Corner, and Pull Posts and Top Rail: As required for Medium Duty fence.
 - 3. Gate Posts, Gates, and Accessories: Comply with ASTM F 654, gate type as indicated, made from Polymer-coated steel metal pipe and tubing for individual gate widths as shown on Drawings with complete with hardware.
- B. Welded Wire Mesh Fabric:
 - 1. Mesh and Wire Size: 2-inch x 4-inch x 12 gauge
 - 2. PVC-Coated Fabric: ASTM F 668, Class 1 over metallic-coated steel wire. Color: Black complying with ASTM F 934.

2.2 TENSION WIRE AND FITTINGS

- A. PVC-Coated Steel Tension Wire: 0.177-inch diameter, marcelled tension wire complying with ASTM A 824 at locations indicated.

- B. Fittings: Provide fittings and turnbuckles for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.

2.3 CAST-IN-PLACE CONCRETE

- A. General: Comply with ACI 301 for cast-in-place concrete; materials consisting of portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and potable water.
 - 1. Concrete Mixes: Normal-weight concrete with not less than 3000-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

2.4 POLYMER FINISHES

- A. Supplemental Color Coating: In addition to specified metallic coatings for steel, provide fence components with polymer coating.
- B. Metallic-Coated Steel Tension Wire: PVC-coated wire complying with ASTM F 1664, Class 1.
- C. Metallic-Coated Steel Framing: Comply with ASTM F 1043 for polymer coating applied to exterior surfaces and, except for tubular shapes, to exposed interior surfaces.
- D. Miscellaneous Components: Comply with ASTM F 626 for the following:
 - 1. Fittings.
 - 2. Post and line caps. Cone shape.
 - 3. Tension and brace bands.
 - 4. Tension bars.
 - 5. Tie wires, clips, and fasteners.
- E. Color: Black complying with ASTM F 934.

2.6 GATE HARDWARE

- A. Hardware: PVC coated steel latch shall have provision for padlocking. Hinges shall grip post and frame firmly to prevent slippage. Hinges shall have a load capacity of 1,000 lbs. and allow gate leaf to swing 180 degrees.
- B. Gate cane bolts to hold gate in open position.

2.7 VIEW RAIL FENCE & GATE

- A, Galvanized Posts and Frames – primed and painted.
 - 1. Fence and Gate Height: as shown on drawings
 - 2. Line, End, Corner, and Pull Posts and Top Rail: As specified on drawings.
 - 3. Gate Posts, Gates, and Accessories: gate type as indicated, made from galvanized (primed and painted) steel metal pipe and tubing for individual gate widths as shown on drawings with complete with hardware.
- C. Composite Wood Rail
 - 1. See Drawings for sizes
 - 2. Color- TBD

- D. Mesh Fabric:
 - 1. Mesh and Wire Size: 2-inch x 2-inch x 1/16" stainless steel mesh, black oxide finish

2.8 BOMA FENCE & GATE

- A, Galvanized Posts and Frames – primed and painted.
 - 2. Fence & Gate Heights: as shown on drawings
 - 3. Line, End, Corner, and Pull Posts and Top Rail: As specified on drawings.
 - 4. Gate Posts, Gates, and Accessories: gate type as indicated, made from galvanized (primed and painted) steel metal pipe and tubing for individual gate widths as shown on drawings with complete with hardware.

- E. Eucalyptus Rustic Timber Assembly
 - 1. See drawings for diameters and lengths sizes
 - 2. 2 x 4 pressure treated wood nailer as shown on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install fencing to comply with ASTM F 567 and more stringent requirements indicated. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.

- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

- C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil.
 - 1. Concrete Footings: Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured. Set the following post types in concrete footings and protect portion of posts aboveground from concrete splatter:

- E. Gate, Terminal and Line Posts; Using mechanical devices to set line posts per ASTM F 567 is [not] permitted.

- F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 70 feet.

- G. Line Posts: Space line posts uniformly at 10 feet o.c.

- H. Set posts plumb in concrete having a diameter 4 times the diameter of the post, and 6 inches deeper than the bottom of the post. Forms are not necessary or recommended.

- I. Check each post for vertical and top alignment.

- J. Caps: Install and secure specified post tops

- K. Tension Wires: Install in one piece as indicated spanning between posts, using fittings, special offset fittings, and accessories.
- L. Fabric: Apply fabric to [outside] [inside] of enclosing framework.
- M. Tie Wires: Attach wire to chain-link fabric per ASTM F 626. Tie fabric to line posts at maximum interval of 12 inches o.c. and to braces at maximum interval of 24 inches o.c.
- N. Gates: Install gate posts a minimum of 36 inches into firm soil. Diameter of the footing shall be a minimum of 4 times the diameter of the post. Footing shall be 6 inches deeper than the bottom of the posts, or a minimum of 42 inches. Finish concrete with a slope for all water to drain away from post.
- K. Attach all hardware to gate in such a way that it cannot be removed by unauthorized persons.
- I. Adjust gate as required. Make sure that gate opens smoothly free of binding.
- J. Attach latch and make sure that gate is received by latch in a secure manner

3.2 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion

END OF SECTION 323113

SECTION 323119 - DECORATIVE METAL FENCES AND GATES

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. Decorative steel / iron fences & guardrails.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for post concrete fill.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Drawings shall include design layouts of the material specified including overall dimensions, heights, accessory details, methods of assembly, hardware data, milling details and foundation details. Submit complete shop and erection drawings for review prior to fabrication or erection. Shop drawings shall contain a certification sealed by a registered professional engineer stating that the components have been designed to the specifications provided.
- C. Substitutions: If substitution of any equipment is required, submit request for approval in writing within 10 calendar days after the date of Notice to Proceed.
- D. Warranty and Maintenance: Submit written warranty and maintenance agreement for all installed materials.
 - 1. Warranty shall be for a minimum of 10 years.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.

2.2 DECORATIVE STEEL / IRON FENCES

- A. Decorative Metallic-Coated-Steel Tubular Picket Fences: Comply with ASTM F 2408 for residential and commercial application (class) unless otherwise indicated.
- B. Decorative Steel / Iron Fences: Fences made from steel tubing bars and shapes, hot-dip galvanized.
- C. Color: All Steel / Iron Fences products shall powder-coated black unless noted otherwise.
- D. PRODUCTS:
 - 1. Manufacturer:
 - a. Ameristar Fence
 - b. Fortress Fence Products
 - c. Hercules Fence
 - d. Iron Eagle Industries
 - e. Iron World Manufacturing
 - f. Master Halco
 - g. Merchant Metals
 - h. XCEL Fencing Systems
 - i. Approved Equal
- E. Posts: Square Steel tubing
 - 1. Line Posts: 2 by 2 inches minimum with 3/16-inch wall thickness.
 - 2. Terminal Posts: 2-1/2 by 2-1/2 inches minimum with 3/16-inch wall thickness.

3. Fabricated of galvanized square steel tubular members per ASTM A787 with a G60 zinc coating, 0.60 oz/ft² and steel to have 45,000 psi (310 MPa) yield strength.
- F. Post Caps: Formed Steel manufactured to form a weather-tight closure. Formed from steel sheet and hot-dip galvanized after forming.
- G. Rails:
1. Steel Tube Rails: Square steel tubing 1-3/8" by 1-3/8" with 1/8-inch wall thickness
 2. Fabricated of galvanized square steel tubular members per ASTM A787 with a G60 zinc coating, 0.60 oz/ft² and steel to have 45,000 psi (310 MPa) yield strength.
- H. Pickets:
1. Pickets: 5/8" square steel tubes
 2. Fabricated of galvanized steel tubular members per ASTM A787 with a G60 zinc coating 0.60 oz/ft² and steel to have 45,000 psi (310 MPa) yield strength.
 3. Extend pickets beyond top rail as indicated.
 4. Picket Spacing: 3" clear maximum.
- I. Rail/Post Brackets: Standard 1 1/2" x 1 3/8" x 1 1/2", 15 gauge galvanized steel channels. Cover to be pressed to bracket for permanent installation. Bracket shall be fastened to post with one galvanized hex bolt. Rails shall be attached to bracket with one-way security fastener.
- J. Rings: Cast aluminum rings attached to rails by insertion of mounting block into upper rail. Rings attached to rails with standard drive rivet to prevent removal.
- K. Metallic-Coated Steel Sheet: Galvanized-steel sheet or Galvalume-steel sheet.
- L. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior
- M. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
- N. Finish: All posts, caps and fence panels shall galvanized individually after fabrication to thoroughly coat all surfaces for additional corrosion protection Components shall be given a TGIC polyester resin powder coating applied by the electrostatic spray process to 3.0 mil thickness. The finish is baked in an oven for 15 — 20 minutes.
- O. Fasteners: Galvanized-steel carriage bolts and tamperproof nuts to match finish of fence. All fasteners shall be corrosion-resistant, color-coated to match exterior of fence.

2.3 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

- D. Bar Grating: NAAMM MBG 531.
 - 1. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.
 - 2. Wire Rods: ASTM A 510
- E. Castings: Either gray or malleable iron unless otherwise indicated.
 - 1. Gray Iron: ASTM A 48/A 48M, Class 30.
 - 2. Malleable Iron: ASTM A 47/A 47M.

2.4 COATING MATERIALS

- A. Primer for Steel: Manufacturer's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 - 1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.6 GROUNDING MATERIALS

- A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
 - 1. Material above Finished Grade: Aluminum
 - 2. Material on or below Finished Grade: Copper.
 - 3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Grounding Connectors and Grounding Rods: Comply with UL 467.
 - 1. Connectors for Below-Grade Use: Exothermic-welded type.
 - 2. Grounding Rods: Copper-clad steel.
 - a. Size: 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work. **Contractor to coordinate final fencing layout with field conditions.**
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 - 1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Finish and slope top surface to drain water away from post.
 - b. Concealed Concrete: Top 2 inches to allow covering with surface material. Slope top surface of concrete to drain water away from post.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
 - 4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.

- a. Extend posts at least 5 inches into sleeve.
 - b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
5. Set line post uniformly at between end posts face unless otherwise indicated.

3.4 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- E. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 ADJUSTING

- A. Lubricate hardware and other moving parts.

3.6 CLEANING

- A. Clean up debris and remove from site.

PART 4 - FINAL ACCEPTANCE

- 4.1 Final acceptance of the work by the Owner or owner's representative will be contingent on Contractor's compliance with warranty and replacement requirements and Architect's approval.

END OF SECTION 323119

SECTION 329115 – AMENDED PLANTING SOIL

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. Amending of existing soil to prepare for installation of planting beds, turf, and specimen trees.

Related Sections:

- 1. Section 329119 – Topsoiling
- 2. Section 329200 – Lawn and Grasses
- 3. Section 329300 – Planting

1.3 STANDARDS

- A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, January, 1998.

- 1. Section 733: Topsoiling

1.4 SUBMITTALS

- A. Legal Documents

- 2. Submit a complete materials list of items to be provided under this section for approval by the Owner's Representative before the purchase of any material.
- 3. Submit a list of proposed methods of execution of work under this section for approval by the Owner's Representative when proposed methods are different from or supplementary to those specified herein.
- 4. Submit copies of soil test recommendations called for in this section.

- B. Delivery Slips

- 1. Submit delivery slip for all shipments showing the product volume and name of supplier.

1.5 PRODUCT DELIVERY AND STORAGE

- A. Obtain all legal rights or easements necessary from private owners on whose lands topsoil may be stored. Furnish rights or easements in written form and signed by both CONTRACTOR and property OWNER involved, or their duly authorized representatives.

1.6 JOB CONDITIONS

- A. Existing Conditions

- 1. Perform work in this scope only after preceding work affecting ground surface is completed.
- 2. Verify locations of all underground utilities prior to start of work.

- B. Environmental Requirements
 - 1. Topsoil shall not be moved or spread in frozen or muddy condition.
- C. Protection
 - 1. Protect trees and shrubs to remain as part of final landscaping against damage.

PART 2 - PRODUCTS

2.1 COMPOST

- A. Compost shall be certified by US Composting Council as STA Organic Compost. Laboratory results of submittal sample shall satisfy the following:
 - Soluble Salts no greater than 10 mmhos/cm
 - % solids content 50-60% (50-40% moisture)
 - Organic matter 30-60%
 - Nitrogen 0.5-2.5 % (dry weight basis)
 - pH 5.0 to 8.0
 - Total Carbon up to 55% by weight
 - C:N Ration less than 20% dry weight basis
 - Pass select pathogens and Trace Metals
 - Bio Assay >95%

2.2 SOIL AMENDMENTS TO ALTER pH AS PER SOIL TEST RECOMMENDATIONS

- A. Dolomite Lime: Shall be agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing No. 65 sieve, Kaiser Dolomite 65 AG or approved equal.

2.3 TOPSOIL

If, after completion of soil amendments, soil volume is insufficient to meet finish grades then topsoil may be imported to job site. See Section 329119 - TOPSOILING.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Do not amend or place any soil or soil amendments until conditions are satisfactory. No work shall be performed when existing conditions are porous, wet, frozen or spongy.
- B. Verify that clearing, earthwork, grading and other preceding work affecting ground surface have been completed and approved by Landscape Architect or Owner's Representative.

3.2 SOIL TESTING

- A. Complete soil test through approved soil testing laboratory from a representative sample of all existing soil to remain on project site in planting beds or turf areas. The soil test should determine mechanical analysis, soluble salt level, N,P,K, levels, pH, organic matter content, cation exchange, micro- nutrient levels, and bulk density. Submit soil test results for approval by Landscape Architect.
- B. Submit lab test results from an approved soil testing laboratory from a representative sample of the proposed imported compost to Landscape Architect for approval a minimum of 30 days in

advance of plans to transport it to the site.

- C. Submit source of compost (name and location) to Landscape Architect for approval.
- D. Submit a physical sample of 1 gal. compost to be provided. This is in addition to submittals to analytical labs made by contractor.

3.3 COORDINATION

- A. Coordinate work to maintain optimum moisture content of materials and existing soil to attain required compaction density.
 - 1. Employ a placement method that does not disturb or damage other work, existing conditions, or surrounding soils.
 - 2. Do not move or set heavy objects over proposed planting areas at any time during project sequence.

3.4 INSTALLATION FOR PLANTING BEDS ONLY (NOT PLANTERS)

- A. Plan sequence of work to minimize compaction of soil and ensure that no heavy equipment will run across finished surfaces. Sequence of work must ensure a uniform profile and prevent localized compaction. (For example, work performed to back machines out of areas where work occurs.) Soil media shall be spread on these areas to a depth sufficiently greater than that specified on the plans. After natural settlement has taken place, the work must be in close conformity to acceptable compaction tolerances and finish grade or meet surrounding edge conditions.
- B. Final soil grades in flat areas will result in slight crowning of the soil, while grades on other areas will be with the intent of guiding runoff to drainage
- C. Remove stones, lumps, roots and other objects larger than one inch in any dimension from graded surface.

3.5 DEWATERING

- A. See Section "Earth Moving" for dewatering measures

3.6 STORAGE OF MATERIALS

- A. Stockpile materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust or importation of weed seed.
 - 1. Stockpile materials away from edge of excavations. Do not store within drip line of remaining trees.

3.7 AMENDING SOIL FOR PLANTING BED AREAS

- A. Loosen existing soil in planting beds to a minimum depth of 12 inches. Loosen existing soil in turf areas to a depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- B. All planting beds shall be amended by spreading horticultural compost over loosened surface to uniform depth of 3". Incorporate compost with existing soil by tilling to a depth of 6 to 8 inches. If required to meet finish grades, place imported topsoil over amended planting soil. If required as per soil test results, apply soil amendments to alter pH and thoroughly blend into planting bed.
- C. Grade planting beds to a smooth, uniform surface with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.
- D. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.8 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place compost on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.9 COMPACTION

- A. See Section Earth Moving for specifications regarding backfill and fill.
- B. Compact planting areas to 90 percent (90%) maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D-1557.

3.10 FINE GRADING

- A. General: Uniformly grade planting areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
 3. Slope grades to direct water away from buildings and to prevent ponding.

3.11 PROTECTION

- A. When required, erect temporary signs and barriers to protect work area.

3.12 MAINTENANCE

- A. Immediately before establishment of planting material, regrade areas which become eroded, settled or otherwise disturbed.
- B. Perform all maintenance work in accordance with the Specifications without additional compensation.
- C. Maintenance period to extend until installation of planting material.

3.13 CLEANING

- A. Immediately clean spills, soil, and conditioners on paved and finished areas.
- B. Haul and dispose of materials in excess of the quantity required for the project off site.
- C. Dispose of protective barricades and warning signs at termination of maintenance period.

END OF SECTION 329115

SECTION 329119 – TOPSOILING

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. Prepare subsoil.
 - 2. Furnish topsoil required from approved sources located outside the project limits, and place as shown on drawings.
- B. Related Sections:
 - 1. Section 329115 – Amended Soils
 - 2. 329200- Lawn and Grasses
 - 3. Section 329300 – Planting

1.3 STANDARDS

- A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, January, 1998.
 - 1. Section 733: Topsoiling

1.4 SUBMITTALS

- A. Legal Documents
 - 1. Submit a complete materials list of items proposed to be provided under this section for approval by the Owner's Representative before the purchase of any material.
 - 2. Submit a list of proposed methods of execution of work under this section for approval by the Owner's Representative when proposed methods are different from or supplementary to those specified herein.
 - 3. Submit copies of soil test recommendations called for in this section.
- B. Delivery Slips
 - 1. Accompany all shipments of topsoil with delivery slip showing the product weight and name of supplier.

1.5 PRODUCT DELIVERY AND STORAGE

- A. Obtain all legal rights or easements necessary from private owners on whose lands topsoil may be stored. Furnish rights or easements in written form and signed by both CONTRACTOR and property OWNER involved, or their duly authorized representatives.
- B. Fertilizer and lime shall be delivered and stored in original unopened packages, kept dry, and not opened until needed for use. Damaged or faulty packages shall not be used.

1.6 JOB CONDITIONS

A. Existing Conditions

1. Perform topsoiling only after preceding work affecting ground surface is completed.

B. Environmental Requirements

1. Topsoil shall not be moved or spread in frozen or muddy condition.

C. Protection

1. Protect trees and shrubs to remain as part of final landscaping against damage.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil furnished from within or outside the project limits.

Contractor shall provide required quantity of topsoil to create a uniform depth of 8" after settlement on areas to be seeded or planted beds. If additional topsoil is required from off-site sources, it shall meet the following requirements:

1. Topsoil shall consist of natural loam topsoil free from subsoil, obtained from an area that has never been stripped. It shall be of uniform quality, free from hard clods, stiff clay, sods, stone, lime, cement, ashes, slag, or other undesirable material.
2. Topsoil shall contain a minimum of 5% organic matter, determined by loss of ignition of moisture-free samples dried in accordance with the current method of the Association of Official Agricultural Chemists. The acidity range shall be pH 5.0 to 7.0 inclusive. Maximum soluble salts: 500 ppm. The mechanical analysis of the soil shall be as follows:

Passing	Retained	Percentage
1" screen	--	100
1" screen	¼" screen (gravel)	3 (maximum)
¼" screen	No. 100 U.S.S. mesh sieve (sand)	40 – 60
No. 100 U.S.S. mesh sieve sand	Very fine sand, silt, or clay	40 – 60

3. The Contractor shall furnish certified report(s) of the testing laboratory showing the analysis of a representative sample of the topsoil for Lawn and Garden use he proposes to use. A separate report shall be furnished for each source of topsoil. The Contractor shall furnish the reports to the Owner's Representative before any topsoil is delivered to the site.
4. The Owner's Representative reserves the right to reject topsoil in which more than 60 percent of the material passing the No. 100 U.S.S. Mesh Sieve consists of clay as determine by the

Bouyoucous hydrometer or by the Decantation method. All percentages are to be based on dry weight of sample. If the Owner's Representative directs, topsoil which varies only slightly from the Specifications may be acceptable by such corrections, as the Owner's Representative deems necessary.

5. If necessary, add peat, or approved composted leaf mold, at rate necessary to attain minimum organic content.

2.2 SOIL AMENDMENTS PER SOIL TEST RECOMMENDATIONS

A. Peat:

1. Shall be peat obtained from fresh water sites of sedge peat, reed peat, and sphagnum deposits consisting of organic matter of incompletely decomposed plant residues containing a negligible amount of woody matter, shredded to resemble texture of cultivated peats. Peat material, not cultivated or aged, shall meet the following requirements: minimum of 85% pure organic matter, maximum of 60% moisture by weight as received, minimum of 100% water absorption for each 24 hours submersion in water by weight, minimum of 350% water absorption from a dry basis by weight, maximum weight as received 30 pounds per cubic foot, equivalent to 2.47 cubic yards/ton.

Material shall pass a 1-inch sieve and not less than 50% be retained on a 1/2-inch sieve.

2. At the discretion of the Owner's Representative, obtain analysis from an accredited soils lab at the Contractor's cost.
 3. If required, add peat to topsoil obtained from sources project limits, at rate necessary to attain minimum organic content of 5 percent.
- B. Mulch: Shall be shredded hardwood bark, 3/4" to 1 1/2" diameter as provided by the Contractor. It should be spread at 3" thick. There is to be no mulch at the crown of the plants. Note on color – not dyed mulch.
- C. Dolomite Lime: Shall be agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing No. 65 sieve, Kaiser Dolomite 65 AG or approved equal.

2.3 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities:

Ratio of Loose Compost to Topsoil by Volume: 1:4

Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: 1 to 2 pounds of water-insoluble nitrogen with a NPK ratio of either 3-1-2 or 3-1-1, unless otherwise indicated by soil tests.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that clearing, earthwork, grading and other preceding work affecting ground surface have been completed.
- B. Final subgrade elevation and contours shall be smooth and uniform. All variations, lumps, ridges, and depressions in subgrade shall be corrected before topsoil work is started. Do not move heavy objects over the proposed subgrade planting areas.
- C. The subsoil shall be loosened to a depth of no less than 6", or as directed by the Owner's Representative.
- D. Do not proceed with topsoiling until conditions are satisfactory.

- E. Preparation of Subsoil
 - 1. Shape and dress area to be topsoiled. This work includes grading to required lines and elevations; removal of all stones, clods, lumps two inches or larger in any dimension; removal of all wires, cables, pieces of concrete, tree roots, and debris or other unsuitable material.
 - 2. Do not proceed with installation of topsoil until this work has been approved.
- 3.2 INSTALLATION
 - A. Place an even layer that will produce required thickness.
Planting Areas – as shown on drawings.
Lawn Areas – 4" topsoil + 2" organic matter, mixed thoroughly;
 - B. Adjust quantities of lime and fertilizer to correspond with soil test results.
 - C. Remove stones, lumps, roots and other objects larger than one inch in any dimension from graded topsoil surface.
- 3.3 DEWATERING
 - A. See Division 31 Section "Earth Moving" for dewatering measures.
- 3.4 STORAGE OF SOIL MATERIALS
 - A. Stockpile satisfactory salvaged surface soil materials as well as imported topsoil, compost, soil amendments, etc. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- 3.5 UTILITY TRENCH BACKFILL
 - A. After utility trench has been backfilled satisfactorily to subgrade, amend subsoil as specified below and fill trench to finished grade with topsoil. To the following depths:
 - 1. Under proposed lawn areas: min. 6 inches of topsoil
 - 2. Under proposed plant beds: min. 6 inches of topsoil.
- 3.6 FILL
 - A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
 - B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
 - C. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under footings and foundations, use satisfactory soil material.
- 3.7 MOISTURE CONTROL
 - A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.8 COMPACTION OF BACKFILLS AND FILLS

- A. See Division 02 Section Earth Moving for specifications regarding backfill and fill.
- B. For the upper level of subgrades under lawn and plant bed areas, compact soil to the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under lawn areas, compact the upper 12 inches below subgrade at 85 percent.
 - 2. Under plant bed areas, compact the upper 24 inches below subgrade at 85 percent.

3.9 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus 1/2 inch.

3.10 SOIL PREPARATION FOR LAWN AREAS

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Disturbed areas and areas stripped of topsoil:

Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

 - 1. Apply compost and fertilizer directly to subgrade before loosening.
 - 2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 3. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into 4 inches of subgrade. Spread remainder of planting soil mix.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Undisturbed area: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least of 4 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.

- a. Apply fertilizer directly to surface soil before loosening.
- 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
- 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.11 SOIL PREPARATION AT PLANTING BEDS

- A. Loosen subgrade of planting beds to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer if necessary from soil test recommendation.
 - 2. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into to 4 inches of subgrade. Spread remainder of planting soil mix.
- H. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.
- I. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.12 PROTECTION

- A. When required, erect temporary signs and barriers to protect topsoiled area.

3.13 MAINTENANCE

- A. Immediately before establishment of planting material, re-topsoil and re-grade areas which become eroded, settled or otherwise disturbed.
- B. Perform all maintenance work in accordance with the Specifications without additional compensation.
- C. Maintenance period to extend until installation of planting material.

3.14 CLEANING

- A. Immediately clean spills, soil, and conditioners on paved and finished areas.
- B. Haul and dispose of topsoil in excess of the quantity required for the project off site.
- C. Dispose of protective barricades and warning signs at termination of maintenance period.

END OF SECTION 329119

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SECTION 329200 – SEEDING LAWN AND GRASSES

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. Seeding of turf lawn and habitat grass areas as shown on drawings.
2. Lawn renovations

B. Related Sections:

1. Division 31 Section - Site Excavation, Filling, Grading
2. Division 32 Section – Topsoiling
3. Division 32 Section – Amended Planting Soils

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Sod: From sod vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of cutting.
- C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- D. Qualification Data: For landscape Installer.
- E. Planting Schedule: Indicating anticipated planting dates for each type of planting.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns until acceptance of substantial completion.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced English speaking full-time supervisor on Project site when planting is in progress.
 - B. Topsoil Analysis: See Division 02 Section "Topsoil" for requirements regarding topsoil testing and analysis. Additionally, for topsoil intended for lawn areas:
 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
 - C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Sod: Per industry standards for delivery and storage.
- 1.7 SCHEDULING
- A. Planting Restrictions: Permanent lawn plantings must occur during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion. For temporary seeding outside of the permanent planting periods, see Division 32 on Earthwork about Erosion Control.

Seeding:

 1. Spring planting: up to May 15
 2. Fall planting: up to September 30
 - B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.
- 1.8 LAWN MAINTENANCE
- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 1. Seeded Lawns: 60 days from date of Final Acceptance.
 - B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
 - C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water lawn at a minimum rate of 1 inch (25 mm) per week.
 - D. Mow lawn as soon as top growth exceeds 3". Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule subsequent mowings to maintain the following grass height:
 1. Mow grass 2 to 3 inches (50 to 75 mm) high.
 - E. Lawn Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of 1 lb/1000 sq ft (0.45 kg/92.9 sq. m) to lawn area.

PART 2 - PRODUCTS

2.1 SEEDING

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Lawn Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 95 percent pure seed, and not more than .5 percent weed seed:
 1. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Tall Fescue: (*Festuca arundinacea*), a minimum of three cultivars.
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 2. Habitat Seed – see information on drawings
- C. Habitat Seed Species- see information on Drawings

2.2 TOPSOIL, SOIL AMENDMENTS, SOIL MEDIA

- A. Refer to Division 02 Section "Topsoil".

2.3 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.4 MULCHES

- A. Straw Hay: Provide air-dry, clean, mildew- and seed-free, threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.5 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
- B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Subsoil Preparation
 - 1. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual and blend slopes into level areas. Remove foreign materials, stones, weeds and undesirable plants and their roots.
 - 2. Remove contaminated sub-soil and rocks and debris larger than 2".
 - 3. Scarify subsoil with a subsoiler to a depth of 6 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil prior to placement of topsoil.
- D. Final Grade Preparation
 - 1. Topsoil Addition. Spread topsoil to a minimum depth of 8 inches over area to be seeded.
 - a. Place topsoil during dry weather and on dry unfrozen sub-grade.
 - b. Power rake area to remove vegetative matter, stones, and foreign, non-organic material over ½" inch diameter.
 - c. Fine grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage. Maintain profiles and contour of sub-grade.
 - d. Manually spread topsoil close to plant materials and buildings to prevent damage.
 - e. Tolerances: Top of topsoil plus or minus ½" inch.

3.3 SEEDING

- A. Seed Application – Lawn & Habitat Areas
 - 1. Apply seed at a rate specified by the specific seed mix evenly in two intersecting directions.
 - 2. Seed application can be applied using one of the following methods after final soil preparation has been completed and accepted. Seed may be applied in one of two methods:
 - a. Hydroseeding by spraying an aqueous mixture on a prepared seedbed.
 - 1) Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 2) Mix slurry with nonasphaltic tackifier.
 - 3) Do not use wet seed or seed that is moldy or otherwise damaged.
 - 4) Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry application at a minimum rate of 500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 lb/acre.
 - 5) Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh and 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

b. Dry Application

- 1) Seed installation either with culti-packer seeder or drop-type/ broadcast spreader.
- 2) Apply in two directions into the top ¼" of soil.
- 3) Rake in lightly.
- 4) Roll seeded area with roller not exceeding 50 lbs.
- 5) Immediately following seeding and compacting, apply mulch.

3.4 FERTILIZERS

- A. Apply a starter fertilizer evenly at the rate of 1 c.y./1000 sq. ft. or otherwise as required by the results of the soil tests into the top 2 inches of soil by cross disking or the other appropriate method.

3.4 LAWN RENOVATION

- A. Renovate any existing lawn damaged during construction or by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
- B. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury it in soil. Remove thatch as necessary.
- C. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
- D. Mow, dethatch, core aerate, and rake existing lawn. Mow turf at lowest setting without scalping the turf.
- E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- G. Topdress with ½" of approved organic material
- H. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 6 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.
- I. Apply seed and protect with straw mulch or sod as required for new lawns.
- J. Water newly planted areas and keep moist until new lawn is established.
- K. Overseeding shall be completed in September with a seed mix and application rate approved by Owner's Representative.
- L. Overseeding operations shall be performed with a vertiseeder

3.5 SATISFACTORY LAWNS

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.6 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures and barricades after grass establishment period.

END OF SECTION 329200

SECTION 329300 – PLANTING

PART 1 – GENERAL

1.1 SUMMARY

- A. This section defines standards for plant selection, handling, installation and care from the project's start through substantial completion, guarantee period and final acceptance at end of the guarantee period.
- B. Section Includes:
 - 1. Furnish all labor, materials, equipment, and supplies and perform all operations required to complete landscaping work as shown on the drawings and hereinafter specified.
 - 2. Excavation of tree pits and planting beds to the required depth. Backfill & disposal of all excavated materials as required.
 - 3. Furnishing and planting of all plants, including woody and herbaceous plants.
 - 4. Installing, watering, staking, guying, and pruning (if directed) all plants until acceptance by Owner.
 - 5. Furnishing and placing of mulch.
 - 6. Maintaining all installed plantings, including watering, until acceptance of the completed work under this Section.
 - 7. Guaranteeing and replacing of sickly, dying and dead plants through a period of Two (2) year following acceptance of the completed work under this Section.
 - 8. Protecting all existing site features from damage during the work of this Section.
 - 9. Maintaining a clean work site throughout duration of planting operations. Clean up of site and removal of any debris at completion of work of this Section.
- C. Related Sections:
 - 1. Section 329119 - Topsoiling
 - 2. Section 329115 - Amended Planting Soil
 - 3. Section 329200 – Lawn and Grasses

1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.
- C. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size of exterior plant required.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant

required.

- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Planting Soil: See Section 329115 – Amended Planting Soil
- G. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- H. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- I. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Submit color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. Samples for Verification: For each of the following:
 - 1. Trees and Shrubs: Three Samples of each variety and size delivered to site for review. Maintain approved Samples on-site as a standard for comparison. Where not feasible, Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality.
 - 2. Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 - 3. Staking and components.

1.4 INFORMATIONAL SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Materials Lists: Within 45 days after award of the Contract, submit a complete list of all materials proposed to be furnished and installed (including sources) under this Section, demonstrating conformance with the requirements specified.
- C. Product certificates signed by manufacturers certifying that their products comply with specified requirements.
 - 1. Manufacturer's certified analysis for standard products.
 - 2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

3. Label data substantiating that plants, trees, and planting materials comply with specified requirements.
- D. Qualification data for firms and persons to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owner's representatives and owners, and other information specified.
- E. Submit project schedule for approval by Owner's representative at least five days prior to planned start of work. Schedule must include milestone dates that are coordinated with other site trades and locations of work.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
- C. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during all times. Provide at least one English speaking person present at all times during execution of this portion of the work, who is thoroughly familiar with the type of plants being installed and the proper materials and methods for their installation, to direct all work performed under this Section. This person shall have a minimum of 5 years experience in handling the specified plants, and should have a set of prints of the project on site.
- D. Provide quality, size, genus, species, and variety of plants indicated on the Plans, in accordance with the applicable requirements of ANSI Z60.1 American Standard for Nursery Stock, revised 2014. The highest horticultural standards shall be practiced from the time of plant purchase though delivery and installation on site to ensure health, vigor and establishment of all plants.
- E. Measurements: Measure trees according to ANSI Z60.1, revised 2014. Do not prune to obtain required sizes.
 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree for height and spread; do not measure branches or roots tip-to-tip.
 2. Other Plants: Measure with stems and foliage in their normal position.
- F. All plants are subject to approval by Owners Representative (OR) who may inspect plants either at place of growth or at site before planting, for compliance with requirements for genus, species, variety, size, and quality. Owners Representative retains the right to further inspect plants for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work and during contract period. Contractor shall remove rejected plants from project immediately and replace with approved replacement, at appropriate planting time, at no cost to Owner..
 1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site. For woody plants and trees: Label at least one (1) plant of each variety and size with a securely attached, waterproof tag bearing legible designation of botanical and common name..
- G. All plants are to be provided as specified. Requests to use plant substitutes, whether for size or species/cultivar, shall be submitted in writing to the Owner's representative for client review and

approval, prior to delivery to the job site.

- H. Nomenclature and interpretation of plant names shall reference the following. Where the names of plant descriptions disagree, the most current information will prevail:
 - 1. The Royal Horticultural Society Horticultural Database (<http://www.rhs.org.uk/>).
 - 2. USDA – The Germplasm Resources Information Network :
 - 3. <http://www.ars-grin.gov/>
 - 6. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois; Most Current Edition.
- I. Plants of a larger size may be used if acceptable to Owner's Representative with a proportionate increase in size of roots or balls, and at no additions to the Contract Price
- J. All plants shall comply with State and Federal laws, including quarantines with respect to inspection, plant diseases and insect infestation
- K. Collected plants may be used only when approved by the Owner's Representative.
- L. Equipment:
 - 1. Provide machinery and equipment necessary for the prompt, professional completion of the work. Such machinery and equipment shall be adequate to the task required and shall be operated by a person skilled and experienced in both operation of the equipment and the implementation of the task.
 - 2. Upon request, promptly furnish satisfactory evidence of the organization and equipment to be made available for the performance of the work.
 - 3. Comply with all Federal and State Department of Agriculture regulations for pest control which, in general, require that contractors operating in infested areas thoroughly clean all equipment units before moving them to non-infested areas. Full information can be obtained from Federal and State Pest Control Personnel.
- M. Documentation and Coordination:
 - 1 Submit, upon request, documentation prior to the start of work under this Section that all plants and related materials have been ordered.
 - 2 Plant delivery to site and timing of installation is to be coordinated with Owner's Representative prior to delivery of plants to site.
 - 3 Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns. If lawns are already established, protect with $\frac{3}{4}$ " plywood, to be removed in manner that ensures viability of existing lawn.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.
- B. Trees: Deliver freshly dug trees. Do not prune before delivery, except as approved by Owner's Representative. Protect bark, branches, and root systems from sun scald, desiccation and drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy natural shape. Provide protective covering during delivery to prevent wind burn.
- C. Handle balled and burlapped stock by the root ball only; do not stand on or tamp directly on root

balls.

- D. Container Plants: Deliver all plants to site in containers that ensure the protection of entire plant including roots and other plant parts against climatic and other injuries. Plants shall be grown or established in containers in which they will be delivered for at least 8 months but not for more than 24 months in advance of final planting. Plants shall be fully rooted into container but not root-bound. Plants with cracked or broken balls of earth when taken from the containers shall not be planted unless acceptable to the Owner's Representative. Do not lift or handle container plants by tops, stems, or trunks at any time.
- E. Deliver trees and plants after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist. Properly protect plants with soil, moist mulch, etc.,
 - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material, if not installed within six hours from delivery.
 - 2. Root balls/plants shall not be permitted to remain un-installed or exposed during periods of freezing weather or extreme weather conditions.
 - 3. Do not remove container-grown stock from containers before time of planting.
 - 4. Water root systems of trees stored on site as often and thoroughly as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

- A. Utilities: Determine location of above grade and underground utilities and perform work in a manner that will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned. The Contractor shall be responsible for the location and protection of all utilities and for repair of any utilities damaged by Contractor's work. Any damage shall be replaced/repaired to Owner's satisfaction at the Contractor's expense.
- B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner's representative before planting.
- C. Work notification: Notify Owner's Representative at least five (5) working days prior to the start of work of this Section.

1.8 COORDINATION AND SCHEDULING

- A. Planting times shall be during one of the following periods. Coordinate planting periods with maintenance periods, as applicable, to provide required maintenance through date of final acceptance.

Spring Planting: April 26 – June 15 (frost-hardy and acclimatized plant material may be planted prior to April 26 and when not restricted by inclement weather limitations).

 - 1. Fall Planting: September 1 – October 15 (plant material may be planted after October 15 and when not restricted by inclement weather limitations).
 - 2. Summer Planting: to be performed on a project by project basis when not restricted by extreme heat and drought conditions, and when a water source and watering equipment are provided and are easily accessible.
 - 3. Dig trees according to the best recommended time, as per fall and/or spring dig hazards. Coordinate planting periods with maintenance periods to provide required maintenance thru date of Substantial Completion.

- B. Proceed with planting only when existing and forecasted weather conditions permit. If projected or current weather will stress plants, reschedule planting/installation times and dates

1.9 PLANT MATERIAL QUANTITIES

- A. In the event that quantity discrepancies or material omissions occur between the Plant List and Planting Plan, Contractor is to immediately notify Owner's Representative for clarification and to receive instruction about how to proceed.

1.10 MAINTENANCE

- A. Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Revise duration of maintenance period below to suit Project. Revise starting date of maintenance period to date of planting completion if preferred.
- B. Maintenance Period: Until date of Final Acceptance, as confirmed in writing by the Owner.

1.11 SOIL ANALYSIS

- A. Soil Analysis: Upon request, obtain analysis of soil from an accredited soil laboratory at the cost of the Landscape Contractor or Project to determine pH and necessary amendments and fertilizers.

1.12 SUBSTANTIAL COMPLETION AND START OF GUARANTEE PERIOD

- A. Upon written notice from the Contractor, the Owner's Representative shall review the work and make a determination if the work is substantially complete.
- B. The date of Substantial Completion of the planting shall be the date when the Owner's Representative accepts that all work in Planting is complete.
- C. All plants must be in a vigorous growing condition at the time of Substantial Completion.
- D. The Plant Guarantee period begins at the date of written notification of Substantial Completion from the Owner's Representative. The date of Substantial Completion for planting may be different than the date of substantial completion for the other sections of the project.

1.14 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Warrant the following living planting materials for a period of two (2) years after the date of Acceptance of Installation, against defects including death and unsatisfactory growth, except for defects resulting from neglect or abuse by Owner, abnormal weather conditions unusual for warranty period, or incidents that are beyond Contractor's control.
 - 1. Trees and Shrubs
 - 2. Herbaceous and groundcover plants
- C. Replace at the direction of the Owner's Representative and in accordance with the Drawings and

Specifications, all plants that are dead (all material that is at least 25% dead, and any tree with a main leader that has died back), plants that are in unhealthy or unsightly condition, plants that have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence.

- D. All replacements shall be plants of the same kind, size, and quality as originally specified.
- E. Warranty shall not include damage or loss of plants caused by fires, floods, freezing rains, lightning, winds over 75 miles per hour, winter kill caused by severe winter conditions not typical of the planting area, by acts of vandalism, or by negligence on the part of the Owner.
- F. Replaced plants shall be furnished, planted, mulched, and watered as part of the warranty.

PART 2 – PRODUCTS

2.1 GENERAL

- A. All plants shall be the kind and size indicated on the plant list and shall be true to name. All plants shall be sound, healthy, vigorous, nursery stock with a normal habit of growth, shall be subjected to nursery root and top spraying, transplanting, etc., and shall have been inspected and approved for sale, transporting and transplanting by all governmental agencies authorized to administer such control. Plants shall be subject to inspection and approval by the Owner's Representative at place of growth and upon delivery to project site for conformity to specifications. Such approval shall not impair the right of inspection and rejection during process of the work. All trees will be tagged in the nursery by the Owner's Representative.
- B. All plants shall be subject to inspection and approval by the Owner's Representative throughout Contract period. All plants are subject to approval by Owner's Representative. The Contractor must submit to the Owner's Representative a letter of certification from the supplying nurseries that plants supplied to the contractor conform to the requirements listed below:
 - 1. Provide trees of sizes and grades conforming to ANSI Z60.1 for type of trees required. Trees of a larger size may be used if acceptable to Owner's representative with a proportionate increase in size of roots or balls, and at no additions to the Contract Price.
- C. Prior to delivery to the site, the Contractor shall arrange with the Owner's Representative a minimum of two nursery visits for the purpose of selecting and tagging plants proposed for the project. This will include all trees as specified. The Owner's Representative shall inspect proposed plants before plants will be permitted on site.
- D. Label at least one (1) tree of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.
- E. Trees with multiple leaders, unless specified, will be rejected

2.2 SHADE AND FLOWERING TREES

- A. Shade trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, free of branches to about 50% of their height, of height and caliper indicated, conforming to ANSI A300 Section 6 for type of trees required.
- B. Provide balled and burlapped trees except where indicated.
 - 1. Container-grown trees will be accepted in lieu of balled and burlapped trees subject to meeting ANSI A300 Section 6 limitations for container stock.

2.3 DECIDUOUS SHRUBS

- A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according ANSI A300 Section 6 for type, shape, and height of shrub.

2.4 CONIFEROUS EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI A300 Section 6.
- B. Form and Size: Specimen-quality, exceptionally heavy, tightly knit, symmetrically shaped coniferous evergreens:
 - 1. Provide balled and burlapped trees.

2.5 BROADLEAF EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI A300 Section 6.
 - 1. Provide balled and burlapped or container plants as per plant schedule.

2.6 GROUNDCOVER PLANTS

- A. Groundcover: Provide groundcover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.7 HERBACEOUS PLANTS

- A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.
- B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.
- C. Vines: Provide vines of species indicated complying with requirements in ANSI Z60.1 as follows:
 - 1 Two-year or older plants with heavy, well-branched tops, with not less than 3 runners 18 inches or more in length, and with a vigorous well-developed root system.
 - 2 Provide field-grown vines. Vines grown in pots or other containers of adequate size and acclimated to outside conditions will also be acceptable.

2.8 REQUIREMENTS FOR BALLED AND BURLAPPED STOCK

- A. Where indicated to be balled and burlapped, provide trees dug with firm, natural ball of earth in which they are grown free of noxious weed matter.
- B. Provide ball size of not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree required. Increase ball size or modify ratio of depth to diameter as required to encompass fibrous and feeding root system necessary for full recovery of trees subject to unusual or non-typical conditions of growth, soil conditions or horticultural practice.
- C. No balled and burlapped plant will be accepted if the ball is cracked or broken either before or during the process of planting. Root balls shall be firmly wrapped with burlap and bound with natural twine or wire mesh

- D. Wrap and tie earth ball as recommended by ANSI Z60.1 for size of balls required. Drum-lace balls with a diameter of 30" or greater.

2.9 CONTAINER STOCK

- A. Container stock shall be grown in its delivery container for not less than six (6) months but not more than 2 years.
- B. Plants shall have well established root systems but not be root-bound.
- C. Plants with cracked or broken balls of earth when taken from the containers shall not be planted.

2.10 BARE-ROOT STOCK

- A. Bare-root stock should have a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size typical of its species.
- B. Plants should be sufficiently packaged and stored to preserve moisture in fibrous root systems to ensure the health and vigor of the plant.

2.11 MULCHES

- A. Mulch is to be 100% natural, free from deleterious materials, and suitable as a top dressing for plants.
- B. Double shredded hardwood bark mulch.
- C. Substitutions may be used only with prior approval from Owner's Representative.

2.12 LANDSCAPE HAND EDGING

- A. Planting beds and tree rings are to be vertically edged with a hand spade or mechanical edger to a minimum depth of 4". The elevation of the planting bed starts at the low point of the cut edge and angles back towards the planting at a 45 degree angle until it reaches the finish grade of the planting bed. Work excess soil back into planting bed.

2.13 TOPSOIL

- A. See Section 32 91 19 - Topsoiling

2.14 SOIL AMENDMENTS:

- A. Fertilizer: "dryROOTS2" root growth enhancer and soil conditioner or approved equal. Apply to soil surface at manufacturer's recommended rates after planting.

2.15 ANTI-TRANSPIRANT:

- A. Shall be "Wilt-Pruf" by Nursery Specialty Products, Inc., 207 East 47th Street, New York, NY 10017, or approved equal, applied as specified by the manufacturer to species as indicated in drawings.

2.16 PLANTING SOIL

- A. See Section 32 91 15 – Amended Planting Soil

2.17 EROSION-CONTROL MATERIALS

- B. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
- C. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

2.18 WATERING EQUIPMENT

- A. Watering Equipment – to be provided on a project-by-project basis, and to remain the property of the Owner at the completion of the project:
 - 1. Gator Bags
 - 2. Ooze Tubes sufficient for watering multi-stem trees or shrubs.
 - 3. Soaker Hose -should be black or dark color which could blend with mulch, and that can be used above or below soil/mulch surface, will not burst if frozen and provides even distribution of water throughout the planting bed. Installed as per manufacturer's specifications and as directed by project.

2.19 STAKES AND GUYS FOR TREES

- A. Stakes, anchors, and wires shall be of sufficient strength to maintain the tree in an upright position in the conditions in which the tree will be installed.
- B. Guy wires shall be galvanized, multi-strand, twisted wire.
- C. At the location where guy wires are attached around the tree, the trunk shall be protected with 20-mm (3/4 in.) diameter rubber hose, black or dark green in color, and of sufficient length to extend past the trunk by more than 105 mm (6 in).

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Verify that planters have been waterproofed and inspected.
- C. Verify the required drainage and irrigation rough-in has been installed and is fully operational.
- D. Verify that subgrades are accurately established before spreading planting soil.
- E. Once bed preparation has been approved, the Landscape Contractor assumes responsibility for subgrades and finish grades in the areas affected.

3.2 PLANT PRUNING

- A. Prune, thin, and shape trees according to standard horticultural practice and as directed by owner's representative. Prune trees to retain required height and spread. Unless otherwise directed by Owner's Representative, do not cut tree leaders; remove only crossing, injured or dead branches.

3.3 PLANTING BED PREPARATION

- A. Loosen subgrade of planting beds, as needed, to promote adequate drainage and soil conditions promoting plant health and root establishment, but which prevents settlement below finished grade of topsoil layers or plantings. Remove all trash from subgrade along with stones and extraneous debris larger than 1" or that will prevent proper installation and establishment of plantings.
- B. All stumps, weeds, vegetation not being retained are to be grubbed out and/or removed.
- C. Install planting soil mix in 6" lifts, gently compacted using hand tamping, to a depth that meets finished grades after natural settlement but which ensures root and plant establishment. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet. Do not over compact planting soil; compaction is subject to review and alteration.
 - 1. Thoroughly blend any soil amendments or fertilizer needed, as per soil test results, into planting soil either before installation of soil lifts, or as lifts are being installed and before tamping. Delay mixing fertilizer with planting soil if planting will not occur within a few days.
- D. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture, ensuring soil surface is free from debris. Rake, remove ridges, and fill depressions to meet finished grades.
- E. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.
- F. Minimize soil disturbance in areas under existing tree canopy or on sloped areas.
- G. Planting beds and tree rings are to be vertically edged with a hand spade or mechanical edger to a minimum depth of 4". The elevation of the planting bed starts at the low point of the cut edge and angles back towards the planting at a 45 degree angle until it reaches the finish grade of the planting bed. Work excess soil back into planting bed.

3.4 PLANTING PIT PREPARATION FOR TREES

- A. Verify that subgrades are accurately established before digging tree pit.
- B. Dig a hole so that depth will enable tree to be installed in a manner that allows the root flare to be at or slightly above Finished Grade after normal compaction, and at the same relationship to finished grade as they were to the ground from which they were dug.
 - 1. C. Planting hole should be 2 – 3x wider than the size of the root ball.

3.5 DELIVERY, STORAGE AND HANDLING

- A. Plants must be sufficiently containerized, packaged, tarped, etc. to ensure viability of plants and the protection of roots and other plant parts against sun scald, drying, sweating, whipping, and other handling damage as well as climatic seasonal and other injuries.
- B. Trees: Deliver freshly dug trees. Do not prune before delivery, except as approved by Owner's Representative. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy natural shape. Provide protective covering during delivery to prevent wind burn. Do

not drop trees during delivery.

- C. Water all trees and plants as needed from time of pick up through substantial completion.
- D. Do not lift or handle container plants by tops, stems or trunks at any time.
- E. Handle balled and burlapped stock by the root ball only; do not stand on or tamp directly on root balls.
- F. Deliver trees and plants after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist. Properly protect plants with soil, moist mulch, etc., in a manner acceptable to Owner's Representative.
 - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material, if not installed within six hours from delivery.
 - 2. Root balls/plants shall not be permitted to remain un-installed or exposed during periods of freezing weather or extreme weather conditions.
 - 3. Do not remove container-grown stock from containers before time of planting.
 - 4. Water root systems of trees stored on site as often and thoroughly as necessary to maintain root systems in a moist condition.

3.6 LAYOUT

- A. Layout specifications and area and perimeter measurements are provided as guidelines only, and are to be confirmed in the field by Contractor(s) and adjusted as necessary and collaboratively with Owner's Representative.
- B. The location of new plants and new planting beds are to be staked out in collaboration with and approved by the Owner's Representative prior to installation.

3.7 PLANT INSTALLATION

- A. All root balls removed from containers will be scarified and roots thoroughly separated prior to planting.
- B. All plastic or no-rot burlap or twine are to be completely removed from the plant ball prior to backfilling with planting soil. Biodegradable burlap and twine and wire cage material shall be cut away from the top 1/3 of the root ball and remove from the site.
- C. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, stop work and notify Owner's Representative for additional direction.
- D. Set plant plumb and in center of planting pit or trench with top of ball raised just above adjacent finish grade enough to allow for normal compaction and sufficient final planting depth, and so surface of root system will be flush with adjacent finished grades after normal settling.
- E. Maintain full depth of planting soil around root system of plants.
- F. Place soil around ball in layers, tamping gently to settle backfill and eliminate voids and air pockets -do not over tamp. When pit is approximately half backfilled, water thoroughly before placing remainder of backfill

3.8 MULCH INSTALLATION

- A. Install mulch on top of raked and prepared planting bed to a depth of 2", see details..
- B. Mulch is to be raked smooth, eliminating pockets and low points.
- C. Mulch is not to be applied so that it touches the bark of woody plants or tree trunks.
- D. For tree rings: At the time of planting, provide 3 inches high continuous soil saucer around perimeter of planting hole. Prior to end of guarantee period, but not sooner than 8 months after planting, contractor is required to shave off the saucer around the mulch ring area and top dress with new mulch. Cover root ball with no more than 1" (depth) of mulch, installed so that mulch does not touch the bark/trunk.

3.9 STAKING AND GUYING – TREES:

- A. Guy and stake trees more than 2.5 -3-inch (75-mm) caliper unless otherwise indicated, or in situations such as sandy or poor soils, in windy locations, or on slopes. Trees that settle out of plumb due to inadequate soil compaction either under or adjacent to the root ball shall be excavated and reset. Trees that have settled out of plumb shall never be pulled straight using guy wires.

3.10 PROTECTION, CLEAN-UP AND MAINTENANCE

- A. During landscape installation, keep pavements clean and work area in an orderly condition. Place 3/4" plywood as needed to protect existing turf, paved areas, etc.
- B. Install plastic safety fencing as needed to provide barrier protection for newly planted areas or areas to be preserved.
- C. Protect new plantings and plants to remain from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damage to new or existing plantings at the expense of the Landscape Contractor.
- D. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.
- E. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees free of insects and disease. Maintain throughout project work period until Substantial Completion. All plantings which appear to be in distress or defective shall be removed immediately and replaced or replanted according to planting times and quality as defined in this section, with specimens of the same species and size as originally specified:
- F. Watering:
 - 1. The contractor shall be fully responsible to ensure that adequate water is provided to all plants throughout the work period until the date of Substantial Completion.
 - 2. Hand water root balls of all plants to ensure that the root balls have moisture above wilt point and below field capacity, and appropriate for the species. As needed, moisture content in each root ball and soil outside the root ball can be tested to determine water content.
- G. Guy Wires and Stakes are to be maintained by Contractor until the end of the Guarantee Period (see section 3.10) to avoid girdling throughout the first growing season, and removed after the

first growing season if site conditions and adequate plant establishment permit.

3.11 ACCEPTANCE AND GUARANTEE

- A. Plants are to be guaranteed as per the following list, starting from the time of Substantial Completion. Defective materials shall be removed immediately and replaced according to planting times and quality as defined in this section, with specimens of the same species and size as originally specified, with new guarantee for the replacement plant starting at time of replacement. Written Final Acceptance shall be provided at the end of the guarantee period by Owner Representative once all conditions of this Section have been met. All plants must be in a vigorous growing condition at the end of the guarantee period:
 - 1. Minimum of 2-year guarantee on all newly installed plant material.
- B. When Maintenance after Substantial Completion is by others, and not awarded to the Contractor:
 - 1. After Substantial Completion Acceptance, the Contractor shall make sufficient site visits to observe the Owner's maintenance and notify the Owner's Representative in writing if maintenance, including watering, is not sufficient to maintain plants in a healthy condition. Such notifications must be made in a timely period so that the Owner can take corrective action and/or schedule a time to review with the Contractor prior to taking corrective action. Notification must define the maintenance needs observed, include a date and request for site review.
 - 2. In the event that the Contractor fails to visit the site and/ or notify the Owner's Representative in writing, with confirmation that Owner's Representative received the notification, lack of maintenance shall not be used as grounds for voiding or modifying the provisions of the warranty.
- C. Contractor is to be responsible for contacting Owner's Representative defined at the start of this section (1) one month prior to end of guarantee period to review health and successful establishment of plantings. Guarantee remains in effect until this final review takes place.

END OF SECTION 329300

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

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.
- B. All work and materials shall be in accordance with Baltimore City Specifications and Details, latest edition.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping joining materials.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Identification devices.
 - 6. Grout.
 - 7. Flowable fill.
 - 8. Piped utility demolition.
 - 9. Piping system common requirements.
 - 10. Equipment installation common requirements.
 - 11. Painting.
 - 12. Concrete bases.
 - 13. Metal supports and anchorages.

1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- C. ABS: Acrylonitrile-butadiene-styrene plastic.
- D. CPVC: Chlorinated polyvinyl chloride plastic.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Identification devices.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 and Smaller:
 - 1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
 - 2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 and Larger:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.; DMD Div.
 - c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or comparable equal:
 - a. Spears Manufacturing Co.
 - b. PolyCam, Inc.
 - c. GF Piping Systems
 - d. ADS, Inc.
2. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 40 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Co.
2. Description: MSS SP-107 CPVC joint or threaded plastic end, rubber O-ring, and union nut. and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities.

2. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

- A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

- B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. EpcO Sales, Inc.
 - d. Hart Industries, International, Inc.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Factory fabricated, union, NPS 2 and smaller.
 - a. Pressure Rating: 250 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

- C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. EpcO Sales, Inc.
 - d. Watts Water Technologies, Inc.
2. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 and larger.
 - a. Pressure Rating: 175 psig minimum.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

- D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.

- c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 and larger.
 - a. Pressure Rating: 150 psig minimum.
 - b. Gasket: Neoprene or phenolic.
 - c. Bolt Sleeves: Phenolic or polyethylene.
 - d. Washers: Phenolic with steel backing washers.
 - E. Dielectric Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 - 2. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 and smaller.
 - a. Pressure Rating: 300 psig at 225 deg F.
 - b. End Connections: Threaded.
 - F. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or comparable equal:
 - a. Perfection Corporation.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
 - 2. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
 - a. Pressure Rating: 300 psig at 225 deg F.
 - b. End Connections: Threaded or grooved.
- 2.4 SLEEVES
- A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
 - B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
 - C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
 - D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.5 IDENTIFICATION DEVICES

- A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 - 2. Location: Accessible and visible.
- C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
 - 1. Material: Fiberboard or Brass.
 - 2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
- F. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
- G. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
- H. Lettering: Manufacturer's standard preprinted captions as selected by Architect.
- I. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
- J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
1. Material: 0.032-inch- thick, polished brass or aluminum.
 2. Material: 0.0375-inch- thick stainless steel.
 3. Material: 3/32-inch- thick plastic laminate with 2 black surfaces and a white inner layer.
 4. Material: Valve manufacturer's standard solid plastic.
 5. Size: 1-1/2 inches in diameter, unless otherwise indicated.
 6. Shape: As indicated for each piping system.
- L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
- M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
 2. Thickness: 1/8 inch, unless otherwise indicated.
 3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
 4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
- N. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
1. Green: Cooling equipment and components.
 2. Yellow: Heating equipment and components.
 3. Brown: Energy reclamation equipment and components.
 4. Blue: Equipment and components that do not meet criteria above.
 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
 6. Terminology: Match schedules as closely as possible. Include the following:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
1. Size: 3-1/4 by 5-5/8 inches.
 2. Fasteners: Brass grommets and wire.

3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.7 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, Portland.
2. Density: 115- to 145-lb/cu. ft.
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
4. Aggregates: ASTM C 33, natural sand, fine.
5. Admixture: ASTM C 618, fly-ash mineral.
6. Water: Comply with ASTM C 94/C 94M.
7. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Section 024100 "Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality at no additional cost to the owner.

3.2 DIELECTRIC FITTING APPLICATIONS

- A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
 - 1. NPS 2 and Smaller: Dielectric unions.
 - 2. NPS 2-1/2 to NPS 12: Dielectric flanges or dielectric flange kits.
- B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
 - 1. NPS 2 and Smaller: Dielectric [couplings or dielectric nipples].
 - 2. NPS 2-1/2 to NPS 4: Dielectric nipples.
 - 3. NPS 2-1/2 to NPS 8: Dielectric nipples [or dielectric flange kits].
 - 4. NPS 10 and NPS 12: Dielectric flange kits.

3.3 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Sleeves are not required for core-drilled holes.
- J. Permanent sleeves are not required for holes formed by removable PE sleeves.
- K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.
 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger
- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
- I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

- J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
- K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End PE Pipe and Fittings: Use butt fusion.
 - 2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
- O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Install dielectric fittings at connections of dissimilar metal pipes.

3.6 EQUIPMENT INSTALLATION

- A. Install equipment level and plumb, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

3.7 PAINTING

- A. Painting of piped utility systems, equipment, and components is specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 - 1. Stenciled Markers: According to ASME A13.1.
 - 2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
 - 3. Locate pipe markers on exposed piping according to the following:
 - a. Near each valve and control device.
 - b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
 - c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
 - d. At manholes and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
 - 1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
 - 2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.9 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger minimum in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Section 055000 "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

SECTION 330507 - UTILITY DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 REFERENCES

A. ASTM INTERNATIONAL (ASTM)

1. ASTM D1784 - (2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
2. ASTM D1785 - (2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
3. ASTM F714 - (2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
4. ASTM F1674 - (2011) Standard Test Method for Joint Restraint Products for Use with PVC Pipe
5. ASTM F2160 - (2022a) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)
6. ASTM F2620 - (2020a; E 2021) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

B. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1. ANSI Z535.1 - (2017) Safety Colors
2. NEMA TC 7 - (2021) Smooth-Wall Coilable and Straight Electrical Polyethylene Conduit

C. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

1. 29 CFR 1926.652 - Safety and Health Regulations for Construction; Subpart P, Excavations; Requirements for Protective Systems

1.2 SUBMITTALS

A. Submittal Procedures.

1. Preconstruction Submittals
2. Statement of Qualifications and Records
3. Horizontal Directional Drilling Plan
4. Product Data
 - a. Pipe
 - b. Drilling Fluids

- c. Additives
 - d. Tracer Wire
 - 5. Design Data
 - 6. Secondary Containment Plan
 - 7. Test Reports
 - a. Soil Test Data
 - 8. Certificates
 - 9. Drill Rod
 - 10. Fusion Technician Qualifications
 - B. Closeout Submittals
 - 1. Record Drawings
 - 2. Complete Work Logs of Guided Directional Drill Operations
- 1.3 QUALITY CONTROL
- A. Qualifications
 - 1. Ensure that the field supervisor and workers assigned to this project are experienced in work of this nature and have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last three (3) years. As part of the bid submission, submit project descriptions which include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type and material, size installed, length of installation, manufacturer of equipment used, and other information relevant to the successful completion of the project.
 - B. Safety
 - 1. Include in directional drilling equipment machine safety requirements a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operator's booth, worker grounding mats, and any other interconnected equipment to a common ground. Equip the drill with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.
 - C. Horizontal Directional Drilling Plan
 - 1. Provide a plan prepared, signed, and sealed by a licensed Professional Engineer. Submit supporting calculations, certifications, and material product data demonstrating the strength of the product pipes for acceptance before the beginning of the installation. Demonstrate that the proposed material satisfies the purpose of the utility and withstands the design and construction stresses and pressures. The HDD Plan will include the following:

D. Layout Plan

1. Provide a plan location of the operation, including entry and exit points, discussing the relationship of the equipment, pipe assembly, and staging areas.

E. Utility Profile

1. Provide a profile of the utility plotted at a scale appropriate for the work.

F. Equipment List

1. Provide a directional drilling equipment list including: drilling rig, drill bit, back-reamer, mud mixing and pumping systems, down-hole tools, guidance system, and rig safety system. Provide calibration records for guidance system.

G. Drilling Fluid Management Plan

1. Provide a drilling fluid management plan to include drilling fluid types and specifications, cleaning and recycling equipment, estimated flow rates, procedures for minimizing drilling fluid escape, and the method/location for final disposal of waste drilling fluids. Provide a frac out control plan, including frac control materials that will be onsite and contact information for emergency personnel.

H. Pedestrian Access

1. When and where installations disrupt pedestrian use of sidewalk for periods exceeding two consecutive days, provide an alternate route that meets current ADA requirements.

I. Method and Procedures

1. Provide an outline of the methods and procedures, describing the pilot hole drilling procedure, the reaming operation, and the pullback procedure, including drawings, schedule of operations, specifications, and method of operation. Include pipe storage and handling details and pipeline assembly and installation procedures.

J. Safety Data Sheets

K. Submit safety data sheets for fluids and additives.

L. Revisions

1. If site conditions change and require modification to the HDD Plan, submit revised drilling plan to achieve successful installation. Explain, in the revised submittal, the anticipated and encountered conditions that mandated the change in plans.

M. Fusion Technician Qualifications

1. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded, and submitted for review.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects will be rejected. Remove defective materials from the job site.
- B. Protect stored piping from moisture and dirt and place on level surface. Store plastic piping protected from direct sunlight.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Drill Rod

- 1. Select the appropriate drill rod to be used. Submit certified statement that the drill rod has been inspected and is in satisfactory condition for its intended use.

2.2 MATERIALS

A. HDPE

- 1. Install 4-inch nominal diameter high-density polyethylene pipe HDPE with a standard dimension ratio of sch 80. Provide pipe conforming to ASTM F2160.
- 2. UL 651A. Pipe is red in color.
- 3. Use butt fusion jointing method for plain end HDPE pipe. Comply with ASTM F2620 for butt fusion joints.

B. Drilling Fluids

- 1. Use a high quality bentonite drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Use only fluid with a composition, which complies with all Federal, State, and local environmental regulations.
- 2. Additives
 - a. Use admixtures as required to address soil conditions and water conditions such as water hardness, acidity, and alkalinity.
- 3. Tracer Wire
 - a. Use a continuous sheathed solid conductor copper wire line, minimum #12 AWG. Sheathing must be color coded to match the utility.

PART 3 EXECUTION

A. EXAMINATION

- 1. Soil Test Data
 - a. Provide written documentation of conformance with AASHTO T 180.

B. INSTALLATION

1. Ensure all utilities are located and clearly marked prior to start of excavation or drilling.
2. Drill Set-Up
 - a. Design and construct the drill entrance and exit pits.
3. Drilling Fluids
 - a. Mix the bentonite drilling fluid with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. Make any required additive adjustments.
4. Drill Entrance and Exit Pits
 - a. Drill entrance and exit pits are required. Maintain at minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the site.
 - b. Do not allow drilling mud to flow freely on the site or around the entrance or exit pits. Remove spilled mud and restore ground to original condition. Provide shore pits in compliance with OSHA Standards, 29 CFR 1926.652
 - c. Drilling near wetlands or water courses requires secondary containment to prevent drilling fluids from entering the wetlands. Secure written approval of a secondary containment plan from the Contracting Officer.
5. Drill Entrance and Exit Angle
 - a. Ensure entrance and exit angles and elevation profile maintains adequate cover to reduce risk of drilling fluid breakouts and ground exit occurs as specified herein. Ensure that entrance and exit angles generate pullback forces that do not exceed 5 percent strain on the high density polyethylene pipe.
6. Pilot Hole
 - a. The type and size of the pilot string cutting head and the diameter of the drill pipe are at the Contractor's discretion.
 - b. Drill the pilot hole along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:
 - i. Vertical Tolerance: Provide minimum cover below channel bottom as specified on the plans. Pilot hole may go deeper if necessary to prevent breakout.
 - ii. Horizontal Tolerance: Plus or minus - 152.4 cm 60 inches from the centerline of the product pipe.
 - c. Curve Radius: No curve is acceptable with a radius less than 304.8 m 1,000 feet
 - d. Entry Point Location: Make pilot hole entry point within plus or minus - 152.4 cm 60 inches of the location shown on the drawings or as directed by the Contracting Officer in the field.

- e. Exit Point Location: Make the exit point location within plus/minus - 152.4 cm 60 inches of the location shown on the drawings or as directed by the Contracting Officer in the field.
 - f. Mandatory pipeline cover requirements are as shown on the drawings or as specified.
7. Guidance Systems
- a. Allow walkover guidance systems where suitable for this project; use a magnetic survey tool locator installed behind the pilot string cutting head and an electric grid (tru-tracker) system for this project; shorter bores not under water ways. Ensure proper calibration of all equipment before commencing directional drilling operation.
8. Reaming
- a. Conduct reaming operations at the Contractor's discretion. Determine the type of back reamer to be utilized by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type is at the Contractor's discretion.
9. Pull Back
- a. Fully assemble the entire pipeline to be installed via direction drill prior to commencement of pull back operations. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with ANSI Z535.1
 - b. Attach wire to top of pipe in such a manner that it will not be displaced during construction operations.
 - c. Support the pipeline during pullback operations in a manner to enable it to move freely and prevent damage. Install the pipeline in one continuous pull.
 - d. Minimize torsion stress by using a swivel to connect the pull section to the reaming assembly.
 - e. Maximum allowable tensile force imposed on the pull section is not to exceed 90 percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe size or materials, the lowest safe pull strength value governs and the maximum allowable tensile force is not to exceed 90 percent of this value.
 - f. Minimize external pressure during installation of the pullback section in the reamed hole. Replace damaged pipe resulting from external pressure at no cost to the Government. Buoyancy modification is at the discretion of the Contractor.
10. Drilling Fluids Disposal
- a. Collect drilling fluid returns in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.
 - b. Dispose of fluids in a manner that is in compliance with all permits and applicable Federal, State, and local regulations. Disposal of the drilling fluids may occur on

approved land owned by the Government subject to written approval from the Contracting Officer. Spread the drilling slurry over the Government-approved disposal area and plow into the soil.

- c. Conduct disposal in compliance with all relative environmental regulations, right-of-way and workspace agreements, and permit requirements.

11. Connection of Product Pipe to Existing Pipeline

- a. After the product pipe has been successfully installed, allow the product pipe to recover for 24 hours prior to connection of the pipeline. Ensure that a sufficient length of the product pipe has been pulled through the hole so that the pull-nose is not pulled back into bore hole due to stretch recovery of the product pipe.

C. FIELD QUALITY CONTROL

1. Daily Work Log

2. Maintain a work log of construction events and operations including, but not limited to, the following for each day's work:

- a. Hours worked.
- b. Log of each drill rod added or withdrawn during drilling, reaming, and pull back.
- c. Groundwater control operations.
- d. Description of soil conditions encountered.
- e. Tools and equipment in use, drilling fluid, fluid pumping rate, and drilling head location.
- f. Any unusual conditions or events.
- g. Reasons for operational shutdown in event work is halted.

3. Drill Logs

- a. Maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at each rod, typically 3.048 m 10 feet along the drill path. In addition, keep logs that record, as a minimum the following, every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:
 - i. Drilling Fluid Pressure
 - ii. Drilling Fluid Flow Rate
 - iii. Drill Thrust Pressure
 - iv. Drill Pullback Pressure
 - v. Drill Head Torque
 - vi. Make all instrumentation, readings, and logs available to the Contracting Officer at all times during operation.

4. Field Tests

- a. Perform field tests and provide labor, equipment, and incidentals required for testing. Submit test results, identifying any results that do not meet requirements, to the Contracting Officer within four days of test completion. Provide corrective action and retest pipe not meeting requirements. Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Contracting Officer.

D. CLOSEOUT ACTIVITIES

1. Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service leaving the entire area involved in a neat condition acceptable to the Contracting Officer.
2. Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and return the surface area to its original condition. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.
3. Provide a post-construction fusion report including the following data for each fusible connection:
 - a. Pipe Size and Thickness
 - b. Machine Size
 - c. Fusion Technician Identification
 - d. Job Identification
 - e. Fusion Joint Number
 - f. Fusion, Heating, and Drag Pressure Settings
 - g. Heat Plate Temperature
 - h. Time Stamp
 - i. Heating and Cool Down Time of Fusion
 - j. Ambient Temperature
4. Submit an electronic copy and three hard copies of the record drawings to the Contracting Officer within five days after completing the pull back. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain, and submit upon completion, signed complete work logs of guided directional drill operations

END OF SECTION 330507

SECTION 330510 – UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Precast Structures.
 - 2. Utility Structure Accessories.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Accessories for structures.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Reinforcement details.
 - 2. Frame and cover design and structure frame support rings.
 - 3. Ladder details.
 - 4. Grounding details.
 - 5. Dimensioned locations and sizes of all openings and sumps.
 - 6. Joint details.
- C. Product Certificates: For concrete and steel used in precast concrete structures, comply with ASTM C 858.
- D. Qualification Data: For qualified professional engineer and testing agency.
- E. Source quality-control reports.
- F. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Comply with IEEE C2.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- B. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 COORDINATION

- A. Coordinate layout and installation of structures with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of pipe and conduit entrances into structures with final locations and profiles of those utilities as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that pipe and conduit runs drain to structures, and as approved by Architect.

PART 2 - PRODUCTS

2.1 PRECAST STRUCTURES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, **or approved equal**:
 - 1. Christy Concrete Products.
 - 2. Cretex Concrete Products West, Inc.; Riverton Division.
 - 3. Oldcastle Precast Group.
 - 4. Oldcastle Precast Inc.; Utility Vault Division.
 - 5. Utility Concrete Products, LLC.
 - 6. Retain-It.
 - 7. ACO StormBrixx (Geocellular Tanks)
 - 8. Nyloplast Storm Structures
- B. Comply with ASTM C 858, with structural design loading as specified on the drawings, and with interlocking mating sections, complete with accessories, hardware, and features.
 - 1. Openings: Precast openings in walls, arranged to match dimensions and elevations of approaching pipes and conduits with the manufacturer's standard allowance, vertically and horizontally, to accommodate alignment variations.
 - a. Openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- C. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.2 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal::
1. Bilco Company (The).
 2. Campbell Foundry Company.
 3. McKinley Iron Works.
 4. Neenah Foundry Company.
 5. Oldcastle Precast Group.
 6. Oldcastle Precast Inc.; Utility Vault Division.
- B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 and A 123.
- C. Structure Frames, Covers, and Chimney Components: Comply with structural design loading specified for structure.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter as indicated on the drawings.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 2. Cover Legend: Cast in. Retained to suit system.
 3. Structure Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387/C 387M, Type M, may be used.
- D. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- E. Sealing Compound: Non-hardening, safe for contact with human skin, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- F. Fixed Structure Ladders: Arranged for attachment to wall and floor of structure. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- G. Cover Hooks: Heavy duty, designed for lifts 60 lbf required.

2.3 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 - EXECUTION

3.1 CORROSION PROTECTION

- A. Aluminum shall not be installed in contact with earth or concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Structures: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to State and Local requirements.

3.4 INSTALLATION OF CONCRETE STRUCTURES

- A. Precast Concrete Handhole and Structure Installation:
 - 1. Comply with ASTM C 891 unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 - 1. Structure Roof: Install with rooftop at least 15 inches below finished grade.
 - 2. Structure Frame: In paved areas and trafficways, set frames flush with finished grade. Set other structure frames 1 inch above finished grade.
- C. Drainage: Install drains in bottom of structures where indicated. Coordinate with drainage provisions indicated.

- D. Structure Access: Circular opening in structure roof; sized to match cover size.
 - 1. Structures with Fixed Ladders: Offset access opening from structure centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with structure roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Fixed Structure Ladders: Arrange to provide for safe entry with maximum clearance from other items in structures.
- F. Field-Installed Bolting Anchors in Structures: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field.
- G. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each structure cover.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground utility structures.
 - 2. Test structure grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems"
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.6 CLEANING

- A. Clean internal surfaces of structures, including sump. Remove foreign material.

END OF SECTION 330510

SECTION 331116 – WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All materials and construction methods shall be in accordance with the City of Baltimore “Standard Specifications for Material, Highways, Bridges, Utilities, and Incidental Structures,” 2006 edition, hereinafter referred to as the “Standard Specifications,” City of Baltimore Standard Details March 2008 and as amended on the drawings.

1.2 SUMMARY

- A. The work consists of furnishing and installation of all water pipes, drinking fountain, water hydrant, pipe fittings, water valves, and appurtenances at the locations as shown on the Contract Drawings and as directed by the Engineer. Included in this work is all excavation and backfill for trenches.
- B. This Section includes water-distribution piping and related components outside the building for water service.
- C. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

- A. DI: Ductile Iron.
- B. PVC: Polyvinyl Chloride

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: For piping including relation to other services in same area, drawn to scale. Show piping and elevations.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. Comply with Carroll County standards for potable-water-service piping, including materials, installation, testing, disinfection and backflow prevention.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. NSF Compliance:

1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type K, seamless water tube, annealed temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

2. Copper, Pressure-Seal Fittings:

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Viega; Plumbing & Heating Systems.

b. NPS 2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

- B. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern, 250-psig minimum pressure rating; or AWWA C153, ductile-iron compact pattern, 350 psig pressure rating.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.3 PVC PIPE AND FITTINGS

- A. PVC, AWWA Pipe: AWWA C900, Class 200, with bell end and elastomeric gasket, and with plain end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - a. Gaskets: F477, elastomeric seal.
 - 3. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - 4. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4. DRINKING FOUNTAIN

- A Drinking Fountain: Haws Model No. 3380FR barrier free pedestal fountain with freeze-resistant valve or approved equal, and all appurtenant materials for a complete operating system as manufactured by Haws Company (1-775-359-4712). Type 304 Stainless Steel satin finish bracket and 11 gauge Type 304 Stainless Steel satin finish basin with integral swirl design, polished chrome-plated brass vandal-resistant bubbler head, polished chrome-plated brass push-button, chrome-plated brass vandal-resistant waste strainer, vandal-resistant bottom plate, 3/16" (.47 cm) galvanized steel top-access pedestal with green powder-coated finish, integral mounting plate, and 1-1/4" IPS waste.
 - 1. Finish: Ebony (Black) powder coated.

2.5 VALVES AND APPURTENANCES

- A. All manufacturers' makes and models of valves, vaults, frames and covers must be on a list previously approved by Baltimore City Bureau of Water and Wastewater.
 - a. Haws Water Valve, Model 6518FR is a fully engineered pneumatic operated freeze-resistant valve system installed below frost line.
- B. Flush Box Hydrant: Murdock-Super Secur Model No. M-575, ¾" Freeze resistant, flush-mounted box hydrant with lock lid, as manufactured by Murdock Company (800-591-9880 or 626-333-2543).

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- F. Underground water-service piping NPS 4 to NPS 8 shall be the following:
 - 1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Division 22 for piping-system common requirements.

3.4 PIPING INSTALLATION

- A. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- B. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
 1. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.
- C. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- D. Sleeves are specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- E. Mechanical sleeve seals are specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- G. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.5 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

3.6 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Concrete thrust blocks.
 2. Locking mechanical joints.
 3. Set-screw mechanical retainer glands.
 4. Bolted flanged joints.
 5. Heat-fused joints.
 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. See Division 22 for piping connections to valves and equipment.
- C. Connect water-distribution piping to existing water piping.
- D. Connect water-distribution piping to interior domestic water piping.

3.8 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Remake leaking joints with new materials and repeat test until leakage is eliminated.
- C. Prepare reports of testing activities.

3.9 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving".

3.10 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

- c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
- d. Submit water samples in sterile bottles. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331116

SECTION 333000 – SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All work shall be in accordance with Baltimore City Specifications and Details, latest edition.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
 - 3. Manholes.

1.3 DEFINITIONS

- A. PVC: Polyvinyl Chloride.

1.4 SUBMITTALS

- A. Product Data: For each type of PVC pipe and fitting, from manufacturer.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
- C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM D3034, SDR-35, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.2 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints, and frame and cover; all in accordance with Baltimore City Standard Details. A factory or field applied protective coating shall be applied in accordance with Baltimore City Standard Details and Specifications.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 48, Class 30B cast iron unless otherwise indicated.

C. Manhole-Cover Inserts:

1. 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:
 - a. FRW Industries; a Syneco Systems, Inc. company.
 - b. Knutson Enterprises.
 - c. L. F. Manufacturing, Inc.
 - d. Parson Environmental Products, Inc.
2. Description: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
3. Type: Solid.

2.3 CLEANOUTS

A. PVC Cleanouts:

1. 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:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS.
 - d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.
2. Description: ASME A112.36.2M, with round, flanged, cast-iron housing, and secured scoriated, medium-dry loading class, cast-iron cover. Include cast-iron ferrule and countersunk brass cleanout plug.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections. Direct tap method is not permitted.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install piping pitched down in direction of flow, at minimum slope of 2 percent unless otherwise indicated.
 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 3. Install piping with 48-inch minimum cover, unless otherwise indicated.
 4. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 - 2. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings compatible with pipe materials being joined.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
- E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings or PVC schedule 40 in sewer pipes at branches for cleanouts, and use cast-iron soil pipe or PVC schedule 40 for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 24 by 24 by 8 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.7 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
- C. Leaks and loss in test pressure constitute defects that must be repaired.

- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 333000

SECTION 334100 – STORM UTILITY DRAINAGE PIPING

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.
- B. City of Baltimore Department of Public Works Specifications Materials, Highways, Bridges, Utilities, and Incidental Structures, 2006.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Nonpressure transition couplings.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.
- B. HDPE: High Density Polyethylene Pipe

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: At least equal to system test pressure. Pipe joints shall be water tight.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of pipe and fitting, from manufacturer.
- C. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic pipe and fittings in direct sunlight.

- B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. PVC Water-Service Piping:
 - 1. Pipe: ASTM D 1785, Schedule 40 PVC, with plain ends for solvent-cemented joints.
 - 2. Fittings: ASTM D 2466, Schedule 40 PVC, socket type.

2.2 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

2.3 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

- A. HDPE Pipe and Fittings, NPS 6 and Larger: Corrugated and smooth lined pipe and fittings manufactured in accordance with requirements of ASTM F 2306, latest edition. Pipe shall be type S with a full circular cross section, with an outer corrugated pipe wall and a smooth inner wall. Fittings shall be water-tight.
- B. HDPE corrugated and smooth lined pipe shall be manufactured from virgin PE compounds which conform with the requirements of cell classification 335444C as defined and described in ASTM D 3350.
- C. Minimum pipe stiffness at five percent deflection shall be as described in ASTM F 2306, Section 6.3 when tested in accordance with ASTM D 2412.

- D. HDPE pipe and fittings shall be supplied by the same Manufacturer. Pipe and fittings from different Manufacturers shall not be interchanged.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in City of Baltimore Department of Public Works Specifications Materials, Highways, Bridges, Utilities, and Incidental Structures, 2006.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install gravity-flow, non-pressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction as required by manufacturer's requirements for non-pressure drainage piping. Use manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with 24-inch minimum cover, unless noted otherwise on the plans.
 - 4. Install PVC piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.

3.4 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.5 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains.
- B. Make connections to existing piping and underground manholes and structures.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3500 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3500 psi.
 - 3. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- C. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

3.6 IDENTIFICATION

- A. Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 - 1. Use detectable warning tape over nonferrous piping.

3.7 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.

- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of the City of Baltimore.
 - 3. Schedule tests and inspections by the Owner with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of the City of Baltimore, UNI-B-6, and the following:
 - a. Test plastic piping according to ASTM F 1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.8 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100