



Smithsonian Institution

Office of Engineering Design & Construction

SPECIFICATIONS

PROJECT NO.: 2399615

PROJECT TITLE: NATIONAL MALL CAROUSEL SITE IMPROVEMENTS

FACILITY: NATIONAL MALL CAROUSEL
JEFFERSON DRIVE
ACROSS FROM ARTS AND INDUSTRIES BUILDING
WASHINGTON, DC

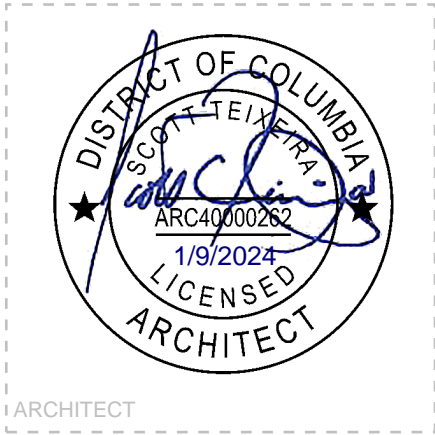
DATE: December 18, 2024

FINAL SUBMISSION

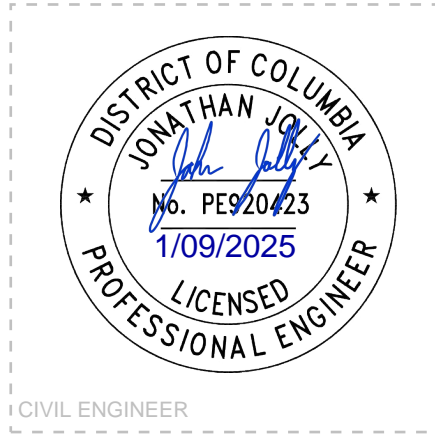
This project is approved as being in conformance with applicable provisions of the Smithsonian Directive (SD) 410.

Michael J. Carrancho, P.E., Associate Director

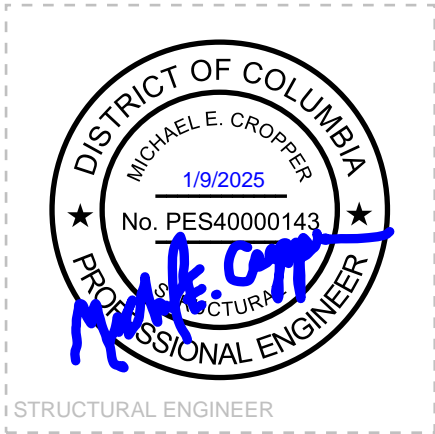
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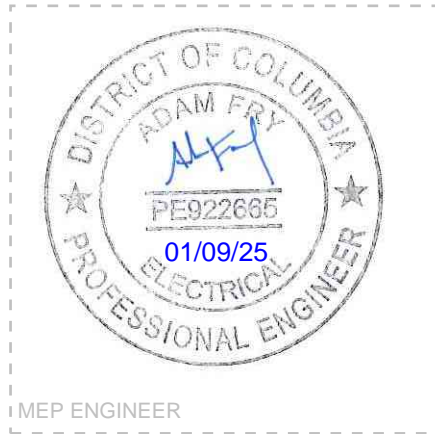
ARCHITECT



CIVIL ENGINEER



STRUCTURAL ENGINEER



MEP ENGINEER

National Mall Carousel
National Mall Carousel Site Improvements
SF Project No. 2399615

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Smithsonian Institution
Washington, D.C.

National Mall Carousel Site Improvements

SF Project No. 2399615

PROJECT DESIGN TEAM

Architect

Hartman-Cox Architects
1074 Thomas Jefferson Street NW
Washington, DC 20007
(202) 333-6446

Civil Engineering

Sorba Engineering
22365 Broderick Drive
Dulles, VA 20166
(571) 771-0273

Structural Engineering

Thornton Tomasetti
1330 Connecticut Avenue, NW
Washington, DC 20036
(202) 580-6300

Mechanical and Electrical Engineering

Mueller Associates
1306 Concourse Dr. Suite 100
Linthicum, MD 21090
(410) 646-4500

AV/IT and Security

GHD
14501 George Carter Way
Chantilly, VA 20151
(571) 325-500

SPECIFICATIONS

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PART 1 - GENERAL

1.1 LIST OF DRAWINGS

- A. List of Drawings: Drawings consist of the following Contract Drawings and other drawings of type indicated:

GENERAL

SHEET NUMBER	SHEET TITLE
G 0 01	Cover
G 0 02	Code
G 0 03	Site Logistics Plan

CIVIL

SHEET NUMBER	SHEET TITLE
C 0 00	Cover Sheet
C 0 01	General Notes
C 1 00	Existing Conditions
CD 1 00	Demolition Plan
CS 1 00	Site Plan
CG 1 00	Grading Plan
CS 1 10	Erosion & Sediment Control Plan
CS 1 20	Erosion & Sediment Control Notes
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CS 5 00	Erosion & Sediment Control Details
CS 5 10	Site Details

TREE PROTECTION

SHEET NUMBER	SHEET TITLE
LP 0 20	Tree Protection Site Plan & Typical Details
LP 0 21	Tree Planting Details

ARCHITECTURAL DEMO

SHEET NUMBER	SHEET TITLE
AD 1 01	Demolition Plan

ARCHITECTURAL

SHEET NUMBER	SHEET TITLE
A 0 01	General Notes
A 0 20	Architectural Site Plan
A 1 01	Plan
A 3 01	Elevations
A 3 02	Section
A 4 01	Enlarged Plan
A 4 02	Enlarged Plan at Concrete Paving
A 4 11	Ticket Booth Details
A 4 12	Ticket Booth Section and Interior Elevations
A 5 01	Fence and Boardwalk Details
A 5 02	Boardwalk Details
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A 8 01	Signage Plan and Schedule

STRUCTURAL

SHEET NUMBER	SHEET TITLE
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E 1 00	Site Plan – Electrical – New Work
E 1 01	Carousel Part Plan – Electrical
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E 6 01	Details & Schedules -- Electrical

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SHEET NUMBER	SHEET TITLE
TA 0 01	Audiovisual Symbols, Notes, & Abbreviations
TA 1 01	Audiovisual Plans
TA 3 01	Audiovisual Rack – Elevations
TA 5 01	Audiovisual Details
TA 6 01	Audiovisual Diagrams

TELECOM

SHEET NUMBER	SHEET TITLE
TN 0 01	Telecom Symbols, Notes, & Abbreviations
TN 1 01	Telecommunications Plans
TN 1 02	Site – Telecommunications Plan
TN 5 01	Telecommunications Details
TN 7 01	Telecommunications Diagrams

SECURITY

SHEET NUMBER	SHEET TITLE
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TY 1 01	Security Plans
TY 1 02	Quad – Security Plan
TY 5 01	Security Details
TY 7 01	Security Diagrams

END OF SECTION 000115 – LIST OF DRAWINGS SHEETS

SECTION 01 0000 - SUPPLEMENTARY CONDITIONS FOR CONSTRUCTION

PROJECT SUMMARY AND INFORMATION

1. PROJECT INFORMATION

1.1. Project No. 2399615
Site Improvements
National Mall Carousel
Jefferson Drive Across from the Arts and Industries Building
Washington, DC

1.2. Smithsonian Institution Contacts:
Office of Contracting and Personal Property Management
600 Maryland Avenue, SW
Suite 500E
Washington, D.C. 20024

Mailing Address:
Smithsonian Institution
Office of Contracting and Personal Property Management
MRC 1200, P.O. Box 37012
Washington, D.C. 20013-7012

Contracting Officer's Technical Representative (COTR)
Attn: Will Hinton
Smithsonian Institution
Office of Planning, Design & Construction
(address for Fed Ex and UPS, delivery):
600 Maryland Avenue, SW
Suite 5001
Washington, DC 20024

2. SUMMARY OF WORK

2.1. The Contractor shall furnish all supervision, labor, materials, and equipment needed to complete the Site Improvements for the Smithsonian's Carousel located on the National Mall on Jefferson Drive across from the Arts and Industries Building, Washington, DC, as set forth in the 54-sheet Drawing set for Project No. 2399615, and in these specifications, dated 12/18/2024.

2.2. The Work includes, but is not limited to:

- 2.2.1 Protection of existing trees and other site elements in areas of work.
- 2.2.2 Application of growth regulator treatments for trees throughout duration of project.
- 2.2.3 Removal of existing ticket booth, fence, designated tree, brick tree borders, asphalt

paving.

- 2.2.4 Perform root investigation and measured drawings for coordination with delegated design of boardwalk system.
- 2.2.5 Remove existing electrical conductors.
- 2.2.6 Construct new site electrical, AV, and Security infrastructure.
- 2.2.7 Remove existing concrete foundations.
- 2.2.8 Construct new concrete foundations.
- 2.2.9 Adjust grades and construct new exposed-aggregate concrete pavement.
- 2.2.10 Design, fabricate, and install new boardwalk system.
- 2.2.11 Design, fabricate, and install new ticket booth.
- 2.2.12 Install new fence.
- 2.2.13 Coordinate with the SI's other carousel restoration contractor, Carousels and Carvings, for installation of SI-furnished and SI-installed gates.
- 2.2.14 Coordinate with the SI's other carousel restoration contractor, Carousels and Carvings for installation of SI-furnished and SI-installed carousel.
- 2.2.15 Installation of new electrical, AV, and Security work.
- 2.2.16 Coordinate with the SI's for installation of SI-furnished and SI-installed graphics and signage.
- 2.2.17 Removal of temporary protection measures.

2.3. Coordination with the SI's Other Carousel Restoration Contractor: The work of this contract supports the concurrent and associated obligations of another contractor engaged by the Smithsonian to remove, restore, and reassemble the carousel and its operating equipment.

2.3.1 Contractor must coordinate their work with all other contractors on site.

2.4. Critical Elements of the Work: The successful Contractor shall be fully qualified to install critical elements of the Work. Upon request of the Contracting Officer, bidders shall submit a statement of qualifications to address the following critical elements of the Work:

- 2.4.1 Custom Fabricated Engineered Ticket Booth
- 2.4.2 Decorative Metal Fences
- 2.4.3 Custom Fabricated Pedestrian Boardwalk System

2.5. Schedule of Options for Proposal: The following is a brief statement of the Work identified for proposal options.

- 2.5.1 Option No. 1 – Sidewalk Replacement:
 - 2.5.1.1 Base Proposal: All work as indicated in the Drawings and Specifications.
 - 2.5.1.2 Option No. 1 Description: The existing sidewalk along the north side of Jefferson Drive exceeds the maximum allowable cross slope. Remove the existing concrete sidewalk and replace in like kind with exposed aggregate concrete sidewalk with compliant cross slope. Refer to special accessibility requirements on Drawing G002.

2.5.2 Alternate No. 1 – Decking Alternative – Composite Wood Decking:

2.5.2.1 Base Proposal: All decking constructed from Kebony (or equal) as indicated in Section

323416 Custom Fabricated Pedestrian Boardwalk System.

2.5.2.2 Alternate No. 1 Description: Provide composite wood decking material furnished by Trex (or equal) in lieu of specified Kebony (BOD).

3. CONTRACT TIME FOR COMPLETION

3.1. Work under this contract shall begin by the Contractor within ten (10) calendar days after the Notice to Proceed and shall be completed within the total contract time of 200 calendar days. All work, including project close-out activities, shall be completed in every respect within the contract time.

3.2. The start date and completion date shall be as stated in the Notice to Proceed issued by the Contracting Officer.

4. OFFEROR EXAMINATION OF SITE

4.1. Every effort has been made to indicate all work necessary to complete the project as identified. All offerors shall carefully examine the premises during the offer period and satisfy themselves as to the extent, nature and location of the work, general and local conditions, particularly those bearing on transportation, disposal, handling and storage of materials, availability of labor, water, electric power, access routes, uncertainties of the weather, type of equipment and facilities needed for the successful execution of the Work.

4.2. Before the offer opening date, offerors may view the project site on an appointment basis. Any comments, information or discussion during the site visit shall not modify the contract documents. Offerors shall make an appointment to view the site by contacting:

Will Hinton
202.633.2343
hintonw@si.edu

4.3. Pre-Bid Conference and Site Visit. Before the *bid opening date, a scheduled pre-bid conference and site visit will be announced by the Contracting Officer. The purpose of the scheduled meeting is to provide an opportunity for all bidders to review the project site. Any comments, information or discussion during the site visit shall not modify the contract documents.

5. NON-PUBLIC, TENANT AND SECURED SPACES

5.1. Not applicable to this project.

6. MUSEUM ARTIFACTS AND SCIENTIFIC RESEARCH MATERIALS

6.1. Not applicable to this project.

7. PROTECTION OF HISTORIC PROPERTIES

7.1. The project site is located on the National Mall and the site and trees are contributing features of the National Mall Historic District. Both the site and its trees require special attention to the quality of materials selected for installation and workmanship efforts to meet the high standards of these contributing features.

7.2. Upon request of the COTR, the Contractor shall submit evidence of technical competence in restoration work for properties listed on the National Register of Historic Places, including subcontractor resumes, references and photographs or previous similar work.

7.3. Without exception, all original site fabric of the National Mall is designated historic.

8. HOURS OF WORK, WORKDAYS, AND GOVERNMENT HOLIDAYS

8.1. Work shall be performed under this contract during the normal workdays of Monday through Friday, except Smithsonian holidays as specified herein, and the normal work hours of 6:00 a.m. to 3:00 p.m.

8.1.1. Any work that will impede traffic will be conducted between the hours 8:00pm – 5:00am

8.1.2. All work that may result to any traffic impediment must be coordinated with the COTR a minimum of 72 hours in advance.

8.2. For each occasion the Contractor intends to work on Saturdays, Sundays or Smithsonian holidays, or during hours other than those indicated above, the Contractor shall obtain written permission from the COTR, at least 3 working days in advance.

8.3. The Contractor shall reimburse the Smithsonian Institution for security and inspection services provided by Smithsonian when the Contractor chooses to work outside the normal workdays and hours, as identified herein. However, the Contractor will not be charged for SI overtime security and inspection services, if in the opinion of the COTR, the work cannot be done during the normal workdays and hours due to requirements of the Smithsonian.

8.4. Smithsonian Holidays. For holidays that fall on Saturday, the Smithsonian holiday is observed on the previous Friday. For holidays that fall on Sunday, the Smithsonian holiday is observed on the following Monday. The Smithsonian holidays are listed below.

New Year's Day	January 1
Martin Luther King Jr.'s Birthday	January, third Monday
George Washington's Birthday	February, third Monday
Memorial Day	May, last Monday
Juneteenth	June 19
Independence Day	July 4
Labor Day	September, first Monday
Columbus Day	October, second Monday
Veterans' Day	November 11

Thanksgiving Day
Christmas Day

November, fourth Thursday
December 25

*President's Inauguration Day

9. QUALITY CONTROL

9.1. The Contractor shall provide a superintendent to be on site at all times during work activities.

9.2. The Contractor shall provide for quality control, inspections, testing and re-testing as necessary for all work, including that of Subcontractors, to assure compliance with the contract documents.

9.3. Contractor Quality Control (CQC) System: The Contractor shall provide a quality control organization and system to perform quality control, inspections, testing and re-testing as necessary for any item of work, including that of Subcontractors, to assure compliance with the contract documents.

9.4. CQC Plan Requirements: The Contractor shall submit for review/approval a CQC Plan within thirty (10) calendar days after Contract Award to the COTR for approval. The Plan shall detail the procedures, instruction and reports to be used to assure compliance with the contract documents. As a minimum, the Plan shall include the following:

9.4.1. Inspection Procedures and Schedule: Identify the inspection and testing procedures and scheduled dates as reflected on the CPM project schedule, organized by technical specification section.

9.4.2. Submittal Review Procedures and Schedule: Provide submittal log in accordance with the Submissions section. For each specification section, identify the name(s) of person(s) authorized to review and sign submittals for compliance.

9.4.3. CQC Documentation: Identify the procedures for documenting quality control operations, inspection and testing. Provide samples of each type of required documentation - all forms, logs, reports, etc. Include a testing log listing all tests and inspections required by the contract documents and stating the action to be taken by the Contractor and/or the Smithsonian.

9.4.4. Daily Reports: The Contractor's Daily Report, as discussed in the section Contractor Correspondence and Daily Reports, shall be signed by the Superintendent. The superintendent's signature certifies that, to the best of his or her knowledge, the report is complete and correct and that all materials, equipment and work described on the report are in compliance with the contract plans and specifications, except as noted otherwise.

9.5. CQC Inspection Requirements: As a minimum, the inspection procedures shall include the following:

9.5.1. Preparatory Inspection Meeting: Preparatory inspection meeting shall be performed before beginning work and before beginning each segment of work. All preparatory inspection meetings shall include a review of the contract requirements, complete review of

shop drawings and other submittals for conformance with contract documents, confirmation that all required testing will be provided, physical examination of all materials and equipment for conformance with approved shop drawings and submittals and verification that all required preliminary work has been completed.

9.5.2. Initial Inspection: Initial inspection shall be performed as soon as a representative segment of the particular item of work has been accomplished. Initial inspection shall include checking of all dimensions, careful inspection of workmanship, performance of required testing, performance of corrective actions as necessary and approval or rejection of the initial segment of the work. Notify the CO'TR once the contractor initial inspection is complete.

9.5.3. Follow-up Inspections: Follow-up inspections shall be performed daily or more frequently, as necessary, and shall include continued testing and examinations to assure continued compliance with the contract requirements.

9.5.4. Non-Compliance Check-Off List: The Contractor shall maintain a check-off list of work that does not comply with the contract, stating specifically what is non-complying, the date the faulty work was originally discovered and the date the work was corrected. The Contractor shall not add to or build upon non-complying work unless, in the opinion of the CO'TR, correction can be made without disturbing the continuing work. The Contractor shall submit a copy of the check-off list to the CO'TR on a monthly basis. Items corrected on the day they are discovered do not need to be included on the submitted list.

9.5.5. Completion and Inspection of Work: The Contractor shall sign the written request for Substantial Completion Inspection (discussed in the Project Closeout Requirements section).

9.6. Special Third-Party Inspection of Amusement Device: The Work of the Smithsonian's other contractor for the restoration of the carousel is subject to inspection by a certified inspector to ensure conformance to National Standards established ASTM Committee F24 and its Subcommittee F24.24 on "Design, Manufacture, Installation and Commissioning".

9.6.1. The Contractor shall engage a certified inspector qualified to perform the above-described inspections in the District of Columbia to provide all regulated inspections for the carousel.

9.6.2. Coordination with the CO'TR and the SI's other contractor for the scheduling of the third-party inspection.

10. CONTRACTOR CORRESPONDENCE AND DAILY REPORTS

10.1. The Contractor shall correspond with the CO'TR for all matters related to this construction project, unless otherwise directed. All correspondence shall be signed and dated by the Contractor and shall reference the project, project number and contract number.

10.2. The Contractor shall maintain daily reports using the Smithsonian Institution

Contractor's Daily Report form. Reports shall be numbered consecutively and all sections shall be completed or noted as "not applicable." Reports shall contain detailed remarks each day, including but not limited to progress on the job, problems discovered and discussions with Smithsonian staff. Reports shall be submitted to the CO^TR each day for the previous workday.

10.3. All correspondence with the Smithsonian Institution shall be in the English language.

11. PERMITS, LICENSES, & FEES

11.1. The Contractor shall obtain and pay for all applicable permits and licenses required by regulating agencies including, but not limited to: National Park Service (NPS), DC's District Department of Transportation (DDOT), DC Department of Energy & Environment (DOEE). Required permits include, but not limited to: permits for pedestrian and road markings, construction fences, sidewalk cuts, utility company connections, elevator certificates, waste containers, etc.

12. PROTECTION OF THE SITE

12.1. The Contractor shall provide adequate protection for all parts of the project site and grounds wherever work under this contract is performed.

12.2. Protection of Vehicular Curbs: Coordinate with the SI and NPS during permitting for the appropriate methods of protection.

12.2.1. As part of NPS permitting requirements, provide information on types, sizes, and weights of vehicles to be used.

12.2.1. Provide manufactured temporary ramp accessories comparable to "Rubber Curb Ramp with Reflectors" Model # PAR-UP-2M available from Traffic Safety Warehouse, <https://www.trafficsafetywarehouse.com/Rubber-Curb-Ramp-w-Reflectors-6-in-tall/productinfo/PAR-UP-2M/>

13. DEBRIS CONTROL AND DAILY CLEANUP

13.1. The Contractor shall clean up the work areas daily and shall at all times maintain the project in as neat and orderly a manner as is consistent with normal operations. Debris resulting from construction operations shall be removed from the site daily by the Contractor; there will be no on-site dumpster. The Contractor shall keep all access, haul routes, and site areas free of dirt, debris, and other materials resulting from construction activities.

14. STAGING, STORAGE, AND WORK AREAS

14.1 Before any work is started, the contractor shall coordinate with the CO^TR regarding the use of area for staging and storage of materials and equipment.

15. BONDING AND INSURANCE

15.1 Bonding: In accordance with IDIQ Contract requirements.

NOTE: The only acceptable method of bonding for the Smithsonian Institution is (1) Bid bond SF-24; Performance Bond SF-25; and Payment Bond SF-25A (U.S. Department of the Treasury Acceptable Surety); (2) Irrevocable Letter of Credit (issued by a member of the Federal Deposit Insurance Corporation); or (3) Cashier's Check.

15.2 Insurance: In accordance with IDIQ Contract requirements.

16. JOB SITE SAFETY

16.1. Safety Coordinator: The Contractor shall designate a person responsible and accountable for personnel safety at both corporate and project level at the project site for the duration of the project. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes. Qualifications for the Safety Coordinator shall include the OSHA 30-hour course or equivalent course.

16.2. Occupational Safety and Health: This contract is subject to Title 29 of the Code of Federal Regulations, Part 1910 "Occupational Safety and Health Standards" and Part 1926 "Safety and Health Regulations for Construction" pursuant to the Occupational Safety and Health Act (OSHA) of 1970 administered by the US Department of Labor, Occupational Safety and Health Administration.

16.3. Report of Accident or Illness: In the event of any accident or illness for which medical assistance is required, any criminal action, or any fire, the Contractor shall notify the appropriate authority (ambulance, police, fire Dept.), Smithsonian Security, and the COTR.

16.4. Contractor Personnel to be contacted: The Contractor shall submit a written list of emergency telephone numbers and names of persons to contact for the General Contractor superintendent and for each major sub-contractor working on the project site. The initial list shall be submitted to the COTR at the Preconstruction Meeting. The list shall be updated and resubmitted to the COTR as needed.

16.5. Site Specific Safety Plan: Upon award of this contract, the contractor shall provide a Site-Specific Safety Plan (SSSP). The SSSP is a safety and health policy and program document and outlines how the contractor will safely conduct their work. This plan shall be job-specific and shall also address any unusual or unique aspects of the project or activity for which it is written.

The SSSP shall interface with the employer's overall safety and health program, and a copy shall be available on the work site. Any portions of the employer's overall safety and health program that is referenced in the SSSP shall be included as appropriate.

17. SUBMITTALS AND REVIEWS

17.1. Contractor Responsibility for Submittals: The Contractor shall provide all required submittals, by technical specification section, in accordance with the contract documents. The Contractor shall

clearly indicate on the submittal that it has been reviewed by the Contractor and found to meet the project requirements. Any items submitted as substitutions shall be clearly identified as such on the submittal and the transmittal document. If shop drawings show variations from the contract documents because of standard shop practices or for other reasons, the Contractor shall provide a separate, written description of variations along with the submittal.

18. TOXIC AND HAZARDOUS SUBSTANCES

18.1. The Contractor shall submit to the CO^{TR}, at least ten working days prior to their intended use, a written list of toxic and hazardous substances that will be used on the project. The Contractor shall submit a "Material Safety Data Sheet" similar to OSHA Form No. 20 for these substances to identify the following information:

- 18.1.1. Product Identification
- 18.1.2. Hazardous Ingredients
- 18.1.3. Physical Data
- 18.1.4. Fire and Explosion Hazard Data
- 18.1.5. Health Hazard Data
- 18.1.6. Emergency and First Aid Procedures
- 18.1.7. Reactivity Data
- 18.1.8. Spill or Leak Procedures
- 18.1.9. Special Protection Information
- 18.1.10. Special Precautions

19. EXISTING FIRE PROTECTION SYSTEMS

19.1. Not applicable to this project.

20. GENERAL SECURITY REQUIREMENTS

20.1. The Contractor and his employees must comply with security requirements imposed by the Smithsonian Institution, including any necessary security clearances. Failure to inspect the site or obtain knowledge of security regulations shall not relieve the Contractor from security requirements or from performance of any part of the work.

21. SCHEDULING & PAYMENTS / BAR CHART

21.1. Project Schedule: The Contractor shall submit to the CO^{TR} for approval a Gantt bar chart project schedule within * 14 calendar days after the date of contract award. No work shall start at the site until the project schedule has been approved by the CO^{TR}. The approved bar chart will represent a baseline schedule on which the monthly construction progress will be indicated and submitted to the CO^{TR}. The baseline project schedule shall comply with the following:

- 21.1.1. Weekly breakdown of work activities shall be provided, including interaction between building trades, subdivided by items of work and areas of the project. Items of work shall be grouped and subdivided according to the divisions of the Construction Specifications Institute (CSI) format.

20.1.2. The start date and completion date shall be consistent with the Contract Time established by the Contracting Officer. Any intermediate deadline dates needed to meet specific requirements for Smithsonian use of portions of the work shall be shown.

21.1.3. Project condition survey activities shall be scheduled not later than the 14th calendar day of the contract time and prior to the start of any site work.

21.1.4. Project closeout activities shall be scheduled for completion in accordance with the requirements for the Contract Time for Completion.

21.1.5. Order dates and projected delivery dates shall be shown for equipment, special devices, hardware, products, or other items requiring long lead time.

21.1.6. Required delivery dates for items to be furnished by Smithsonian and installed by the Contractor shall be shown, as well as items to be furnished and installed by Smithsonian which will affect the Contractor's work.

21.1.7. Review periods for all submittals and time required for all necessary inspection and/or testing shall be shown.

21.1.8. Dates shall be given for ordering, delivery, installation, and testing of major equipment and special materials and equipment.

21.1.9. The Contractor shall specifically identify work activities and dates associated with construction bid alternates.

21.2. Revisions to Baseline Schedules: The Contractor shall submit to the COTR for approval all revisions to the approved baseline project schedule. The Contractor shall submit a proposed revision to the schedule as necessary along with proposals for construction changes, clearly indicating modifications to the schedule based on the proposal. The Contractor shall also submit for review and approval any proposed changes to the schedule due to inability to accomplish the work as planned, for any reason. Approved changes to the schedule shall be incorporated into the Project Schedule, and it shall be resubmitted as necessary or as requested by the COTR.

21.3. Progress Behind Schedule: If it becomes apparent to the COTR that the overall progress of the project is behind the approved project schedule, then the COTR will notify the Contractor in writing. The Contractor shall submit to the COTR for approval a Recovery Schedule and Plan to describe how the Work will be accelerated to meet the Contract Time requirements in accordance with the General Conditions contract clause entitled "Commencement, Prosecution, and Completion of the Work". The Recovery Schedule shall be superimposed on the approved baseline project schedule to demonstrate that proposed recovery activities will accomplish completion of the work by the approved completion date.

21.4. Reporting Progress and Applying for Payment: Each month the Contractor shall apply for payment and submit a report of the actual construction progress as follows:

21.4.1. By the 25th of each month, the Contractor and the COTR shall have inspected the work to determine percentages complete for each item, projected through the end of the month. The parties shall attempt to reach agreement on each item, but if they cannot reach an agreement the COTR will determine percent complete.

21.4.2. By the last day of the month, the Contractor shall submit an Application for Payment based on the determined percentages complete for each item. The application shall be submitted in triplicate on the Smithsonian standard Application for Payment form. Each copy of the Application for Payment shall be accompanied by the following:

A. a Progress Schedule identifying the cumulative progress superimposed on the latest revision of the approved Project Schedule. The net progress for the month and applicable dates shall be clearly indicated.

B. a complete set of copies of certified weekly-payroll data for the period.

21.5. Response to Application

21.5.1. Payment shall be made only for progress agreed upon by the CO'TR, performed on original Contract Work or approved modifications, in accordance with the current, approved Project Schedule. Failure to submit the Application in accordance with the specifications will prevent the processing of payments.

21.5.2. Payments will be mailed to the Contractor's address as identified in the contract documents on record with the Contracting Officer. Any changes of address or requests for wire transfer of progress payments must be made in writing, signed by the Contractor's authorized person, and submitted to the Contracting Officer.

22. WARRANTY OF CONSTRUCTION

22.1. The Contractor shall warrant that the work performed under this contract conforms to the contract requirements and is free of any defect in equipment, materials, design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier. Unless otherwise stated in the technical sections of the Specifications, the warranty of the Work shall continue for a period of one (1) year from the date of Final Completion status. If Smithsonian takes partial occupancy before Final Completion, then the warranty for that portion shall be in effect for a period of one (1) year beginning on the date of Substantial Completion for that portion of the Work.

22.2 Submission of original warranties for all products, equipment, and systems:

22.2.1. The Contractor shall assemble original warranty certificates or notarized copies of warranty certificates executed by the Contractor, subcontractors, suppliers, and manufacturers in a tab-indexed three-ring loose leaf binder with a durable plastic cover. The table of contents shall identify the item covered, the location of the item, the date of Substantial Completion, expiration date of the warranty, and the supplier, vendor, and installing contractor. Duplicate notarized copies of warranties shall be provided as required by "Submission of Operation and Maintenance Manuals".

22.2.2. Include electronic copy in PDF format on a portable USB storage device (a.k.a. "flash drive").

22.3 Special Warranty Documentation Requirements:

22.3.1. The Contractor is responsible for reporting all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement during warranty period.

22.3.2 Documentation of maintenance and repairs to be provided to the CM prior to asset turnover. This applies to all assets that will be installed.

23. SUBMISSION OF OPERATION AND MAINTENANCE MANUALS

23.1. The Contractor shall submit, to the COTR, three (3) sets of manuals for all systems and equipment, as specified in the technical sections of this specification. The manuals shall be bound in letter-sized, three-ring, loose-leaf binders with durable plastic covers. They shall be organized into suitable volumes of manageable size using the divisions of the Specifications as a guide. Each manual shall have a table of contents and shall be assembled to conform to the table of contents with tab sheets locating each subject. The instructions shall be legible and easy to read. Where oversize drawings are necessary, they shall be folded to be not greater than letter-size. The words "Manuals for Operation, Maintenance and As-Built Product Data" the name and location of the project, project number, contract number, date and the name of the general contractor, shall appear on the cover. Data shall be specific to the equipment that is installed and reflect all approved changes and substitutions. Data shall also reflect any required or recommended seasonal adjustments or inspections. Include electronic copy of manual, in PDF format, on a portable USB storage device (a.k.a. "flash drive").

23.2 Manuals shall include, as a minimum, the following data:

- 23.2.1. Notarized copies of warranties (originals to be provided as required by "Warranty of Construction") for all products, equipment, and systems.
- 23.2.2. Installation instructions.
- 23.2.3. Maintenance instructions.
- 23.2.4. Approved product data, shop drawings and system as-builts.
- 23.2.5. Parts list, including source of supply, recommended spare parts and service organization convenient to Smithsonian.
- 23.2.6. Name, address and telephone number of each subcontractor who installed equipment and systems, local representative for each type of equipment and each system.

END OF SECTION 01 0000

SECTION 014500- QUALITY ASSURANCE: STRUCTURAL TESTING AND INSPECTION

PART 1 - GENERAL

1.1 GENERAL

- A. Quality assurance is testing and inspection to assist the Owner in evaluating the Contractor's performance and quality control in the fabrication shop and field. It is not a substitute for the testing and inspection which is required as part of the Contractor's quality control program.
- B. Cost: Except as specifically noted otherwise, the testing agency for quality assurance shall be engaged and paid by the Owner.
 - 1. The Owner has negotiated inspection services based upon the assumption that all fabrication work shall be performed at one single fabrication shop. Costs associated with work being performed in additional shops will require reimbursement to the Owner.
- C. Definitions:
 - 1. See Sections 033000 and 051200.
 - 2. The term "Testing Agency" in this Specification section is defined as an independent testing and inspection service engaged by the Owner for quality assurance testing and inspection of structural construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.
 - 3. The term "Geotechnical Engineer" in this Specification section is defined as an independent geotechnical engineering service engaged by the Owner for quality assurance testing and inspection of the actual soil conditions to verify compliance with the geotechnical conditions, recommendations and design values described in the Project Geotechnical Report and used as the basis of design for the most current Contract Documents.

1.2 SCOPE

- A. Testing Agency shall provide qualified personnel at the site to test and inspect materials installed by and work performed by the Contractor, for the following structural items as indicated in Part 3 of this Specification section:
 - 1. Section 031000 Concrete Formwork
 - 2. Section 032000 Concrete Reinforcement and Embedded Assemblies
 - 3. Section 033000 Cast-In-Place Concrete
 - 4. Section 051200 Structural Steel
 - 5. Section 051210 Structural Steel Additional Seismic Requirements
 - 6. Section 316316 Auger Cast-In-Place Piles
- B. Refer to the drawings for Special Inspections requirements for the Project. The Special Inspections shown on the drawings may contain additional testing and inspection that is not listed in this specification section.

1.3 TESTING AGENCY QUALIFICATIONS

- A. Testing Agency shall be an independent agency with the experience and capability to conduct testing, inspection and sampling as indicated in accordance with ASTM E 329.
- B. Testing Agency shall be an agency approved by the local building official to perform Special Inspections and other related services as outlined in the governing project Building Code.
- C. Testing, inspection, and sampling shall be done in accordance with the applicable ASTM standards.
- D. Personnel performing visual inspection and non-destructive testing of welds shall meet the requirements of AWS D1.1 for weld inspectors and shall have current certification as an AWS Certified Welding Inspector.

1.4 TESTING AGENCY RESPONSIBILITIES

- A. Provide qualified personnel at the site to test and inspect structural construction as the work progresses using the most current Contract Documents and approved shop drawings.
- B. Provide additional testing and inspection as needed due to the following:
 - 1. Work performed contrary to Drawings and Specifications
 - 2. Work performed with improper supervision
 - 3. Work performed without prior notice
- C. Report deficiencies to Contractor, Owner, Design Professionals within 24 hours.
- D. Rejection: The Testing Agency has the right to reject any material at any time, when it is determined that the material or workmanship does not conform to the Contract Documents and shall immediately notify the Owner, Design Professionals, and Contractor of deficiencies. Failure to detect any defective work or material shall not prevent later rejection when such a defect is discovered nor shall it obligate Design Professionals for final acceptance.
- E. Noncompliance Log: Indicate to the Contractor where remedial work must be performed and maintain a current log of work not in compliance with the Contract Documents. This noncompliance log shall be submitted to the Design Professionals and Owner on a weekly basis.
- F. Reports: Prepare daily inspection, observation, and/or test reports as required herein and provide an evaluation statement in each report stating whether or not the work conforms to requirements of Specifications and Drawings and shall specifically note deviations from them. The daily reports shall be collected and submitted for record to the Design Professionals and Owner weekly.
- G. Certification: Upon completion of work and resolution of remedial items, certify in a letter to the Design Professionals and Owner, that the installation is in accordance with the requirements of the Drawings and Specifications.

1.5 CONTRACTOR RESPONSIBILITIES

- A. The Contractor shall have sole responsibility for coordinating their work with the Testing Agency to assure that all test and inspection procedures required by the Contract Documents and Public Agencies are provided. The Contractor shall cooperate fully with the Testing Agency in the performance of their work and shall provide the following:
1. Information as to time and place of starting shop fabrication and field construction/erection, at least one week prior to the beginning of the work.
 2. The most up to date construction schedule.
 3. At least 24 hours advance notice of work requiring testing and inspection.
 4. Access to areas as required for testing and inspection.
 5. Site File: At least one copy of the most current Contract Documents and approved shop drawings shall be kept available in the contractor's field office. Drawings not bearing evidence of approval and release for construction by the Design Professionals shall not be kept on the job. Provide drawings for the work to be performed in the shop or field one week prior to the start of work.
 6. Representative material samples requested by the Testing Agency for testing, if necessary.
 7. Full and ample means of assistance for testing and inspection of material.
 8. Facilities for proper storage of material samples as required.
 9. Proper facilities, including scaffolding, temporary work platforms, safety equipment etc., for inspection of the work in shop and field.
- B. Immediately notify the Owner's Testing Agency and Design Professionals in writing of conditions that will adversely affect the work.
- C. Materials and installed work may require testing and retesting at any time during progress of work, as directed by Design Professionals. Tests, including retesting of rejected materials for installed work will be done at Contractor's expense.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Testing Agency shall provide qualified personnel at site to test and inspect structural construction using the latest Contract Documents and approved submittals as indicated in the following sections.

3.2 CONCRETE FORMWORK

- A. Quality Assurance:
1. Prior to placement of reinforcement, inspect formwork for grade, quality of material, absence of foreign matter, and other imperfections that might affect concrete placement and tolerances stated herein.
 2. Inspect formwork for shape, location and dimensions of the concrete member being formed.
 3. Inspect formwork for compliance with specified tolerances, block outs, camber, shoring ties and seal of form joints.

4. Verify condition of bond surfaces, locations and sizes of all accessories, embedment items, and anchorage for prevention of displacement.
5. Verify proper use/application of form release agents.
6. Verify in-situ concrete strength meets requirements for formwork removal in specification section 031000 prior to removal of shores and formwork from beams and structural slabs.
7. Inspect concrete surfaces immediately after removal of formwork and prior to any patching or repair work.

3.3 CONCRETE REINFORCEMENT AND EMBEDDED ITEMS

A. Quality Assurance:

1. Prior to placement, inspect reinforcement and embeds for grade, quality of material, absence of foreign matter, and for suitable storage.
2. Provide continuous inspection of reinforcement and embedded assemblies during placement and immediately prior to concreting operations for: size, quantity, vertical and horizontal spacing and location, correctness of bends and splices, mechanical splices, clearances, compliance with specified tolerances, security of supports and ties, concrete cover, and absence of foreign matter.
3. Inspect epoxy-coated reinforcement for coating damage and required applied coatings.
4. Provide continuous inspection of adhesive anchors installed in horizontal or upwardly inclined orientations and those marked (CERT) on the latest Drawings.
5. Adhesive anchors shall be proof tested in tension as follows:
 - a) Testing Agency shall submit an adhesive anchorage proof testing plan to the SER for review and approval prior to performing the anchor proof testing. The anchorage testing plan shall meet the requirements as specified in this section and indicate which anchors have been selected for testing.
 - b) Proof testing shall be performed as a confined tension test in accordance with the guidelines of ASTM E488 and the requirements of ACI 355.4.
 - c) Testing shall be performed after the minimum curing period specified by the manufacturer.
 - d) 5 percent of each type and size of an adhesive anchor assembly and 100 percent of anchors marked (CERT) shall be proof tested in tension by the Owner's Testing Agency.
 - e) All anchors selected for proof testing shall be production anchors. Sacrificial anchors are not acceptable for inclusion in the proof testing plan unless specifically approved by the SER prior to performance of the testing.
 - f) The adhesive anchors proof tension loads shall be as specified in the general notes of the structural drawings.
 - g) Anchors shall have no visible indications of displacement or damage during or after proof load application. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure.
 - h) If more than 10% of the tested adhesive anchors fail to achieve the specified proof load, 100% of the anchors of the same diameter and type as the failed anchor shall be proof tested, unless otherwise direct in writing by the SER. Immediately notify the SER of all failed proof tests.
6. Mechanical post-installed anchors shall be proof tested as follows:

- a) Testing Agency shall submit a mechanical anchorage proof testing plan to the SER for review and approval prior to performing the anchor proof testing. The anchorage testing plan shall meet the requirements as specified in this section and indicate which anchors have been selected for testing.
- b) 5 percent of each type and size of mechanical anchor shall be proof tested by the Owner's Testing Agency. The required proof test for the anchors is as follows:
- c) For torque-controlled mechanical anchors, a proof torque shall be applied to the anchor using a calibrated torque wrench and the proof torque shall be achieved with no more than one-half turn of the anchor nut.
- d) [For displacement-controlled mechanical anchors, proof of set is to be achieved by inserting the proper setting tool into the anchor and verifying that full set has been achieved.]
- e) The required proof torque load for torque-controlled mechanical anchors shall be as specified in the general notes of the structural drawings.
- f) All anchors selected for proof testing shall be production anchors. Sacrificial anchors are not acceptable for inclusion in the proof testing plan unless specifically approved by the SER prior to performance of the testing.
- g) Concrete cracking in the vicinity of the anchor during or after proof torque load application shall be considered a failure.
- h) If more than 10% of the tested mechanical anchors fail to achieve the specified proof torque load or set, 100% of the anchors of the same diameter and type as the failed anchor shall be proof tested, unless otherwise direct in writing by the SER. Immediately notify the SER of all failed proof tests.

7. Periodic inspection for post-installed adhesive and mechanical anchors shall be provided in accordance with the building code except that continuous inspection shall be provided for the conditions identified in section A.4. The inspector shall observe all aspects of the anchor installation and shall, at a minimum, verify the following items:

- a) Hole drilling method in accordance with the Manufacturer's Published Installation Instructions (MPII) and these installation requirements.
- b) Anchor spacing and edge distance.
- c) Hole diameter and depth.
- d) Hole cleaning in accordance with the MPII.
- e) Anchor element type, material, diameter, and length.
- f) For adhesive anchors, adhesive identification and expiration date.
- g) For adhesive anchors, adhesive installation in accordance with the MPII.
- h) For torque-controlled mechanical anchors, the number of turns required to achieve the anchor set torque per the MPII.

3.4 CAST-IN-PLACE CONCRETE

A. Quality Assurance:

1. Monitor concrete placement as follows:

- a) Verify use of required design mix
- b) Record location of point of concrete discharge of each batch truck tested, cross referenced to grid lines.

- c) Record temperature of concrete at time of placement.
- d) Record weather conditions at time of placement, including temperature, wind speed, relative humidity, and precipitation.
- e) Record types and amounts of admixtures added to concrete at the project site.
- f) Record amount of water added at the site and verify that total water content does not exceed amount specified in the mix design. Addition of water at the site is subject to prior approval by the Design Professional.
- g) Monitor consistency and uniformity of concrete.
- h) Monitor preparation for concreting operations, placement of concrete, and subsequent curing period for conformance with Specifications for following procedures:
 - i. Concrete curing.
 - ii. Hot weather concreting operations.
 - iii. Cold weather concreting operations.

2. Conduct tests of concrete as follows and in accordance with ASTM C 1077:

- a) Testing frequency: Sample sets for all tests listed below of each concrete design mix placed each day shall be taken not less than once a day, nor less than once for each 50 cubic yards. (40 cubic meters) of concrete, nor less than once for each 2500 square feet (250 square meters) of surface area for slabs or walls. Additional tests shall be performed if deemed necessary by the Owner's Testing Agency and Design Professionals. In addition, sample each truckload used for columns, regardless of other frequencies listed above.
- b) Obtain each test sample from different batches selected on a strictly random basis before commencement of concrete placement. Record location in structure of sampled concrete.
- c) Determine air content of normalweight concrete in accordance with either ASTM C 231 or ASTM C 138. Determine air content of lightweight concrete in accordance with ASTM C 173. Conduct one test for air content for each strength test required or for every 50 cubic yards (40 cubic meters) of fly ash concrete placed, whichever is less.
- d) Determine unit weight of lightweight concrete in accordance with ASTM C 567.
- e) Test water content of freshly mixed concrete on a random basis, a minimum of once per 100 cubic yards (75 cubic meters) or every 5000 square feet (500 square meters) of concrete placement, during placement in accordance with AASHTO T 318 for the following concrete types:
 - i. Hard troweled slabs exposed to view
 - ii. Slab to receive a bonded finish floor material
 - iii. Slabs with specified concrete compressive strength exceeding 6000 psi (42MPa)
- f) Conduct slump tests in accordance with ASTM C 143.
- g) Slump indicated in mix designs shall be achieved at point of placement. Correlation between slump at point of initial discharge from truck and point of placement must be established to determine amount of slump loss which occurs between initial discharge and point of placement. Adjustment

may be necessary to achieve slump indicated in mix designs at point of placement.

- h) Conduct slump tests for Self Consolidating Concrete (SCC) as follows
- i. In accordance with ACI 237, where SCC is used, perform slump flow and visual stability index tests in accordance with ASTM C1611 on the first batch of SCC, and then consecutive batches until two consecutively produced batches are within specification. SCC with a visual stability index value of 2 or 3 shall be stabilized, where possible, with a viscosity modifying admixture or rejected at the discretion of the Engineer and Ready Mix Quality Control Representative. The Ready Mix Producer shall be responsible for adjusting the mix to provide desired flow and stability. After establishing the consistency of the SCC mix, testing shall continue in accordance with the requirements of the above paragraph.
 - ii. In accordance with ACI 237, where SCC is used, perform slump flow tests in accordance with ASTM C1621 using a J-ring to determine the passing ability of the SCC mix around reinforcement. If the reinforcing bars retain the coarse aggregates inside the ring, the mixture has a high potential for blocking and should be reportioned at the direction of the Engineer and Ready Mix Quality Control Representative.
- i) Conduct strength tests of concrete as follows:
- i. Secure sample sets in accordance with ASTM C 172.
 - ii. Mold cylinders in accordance with ASTM C 31 and cure under standard moisture and temperature conditions in accordance with ASTM C 31, Section 7 (a). Quantity of cylinders listed below is based on a cylinder size of 4 inch (100mm) diameter x 8 inches (200mm) long. If 6 inch (150mm) diameter by 12 inch (300mm) long cylinders are used, the total quantity of cylinders may be reduced by one with two cylinders instead of three tested at the age designated for determination of f'_c .
 - iii. Test cylinders in accordance with ASTM C 39. For specified concrete strength of 10,000 psi (70MPa) and above, cylinders shall be ground and not capped.
 - iv. For 28 day mixes mold six cylinders. Test two cylinders at seven days and three cylinders at 28 days. The 28 day strength shall be the average of the three 28 day cylinders. One cylinder shall be retained in reserve for later testing if required.
 - v. For 56 day mixes mold seven cylinders. Test one cylinder at seven days, two cylinders at 28 days, and three cylinders at 56 days. The 56 day strength shall be the average of the three 56 day cylinders. One cylinder shall be retained in reserve for later testing if required.
 - vi. For 90 day mixes mold eight cylinders. Test one cylinder at seven days, one at cylinder at 28 days, two cylinders at 56 days, and three cylinders at 90 days. The 90 day strength shall be the average of the three 90 day cylinders. One cylinder shall be retained in reserve for later testing if required.
 - vii. When early age concrete strength verification is required by the Contractor for formwork removal or stressing of post-tensioning

- tendons, strength shall be verified, at the Contractor's expense, by additional compression tests of field-cured cylinders or by the maturity method in accordance with ASTM C1074.
- viii. If one cylinder in a test manifests evidence of improper sampling, molding or other damage, discard cylinder and base test results on that of remaining cylinder.
3. Evaluate concrete for conformance with Specifications as follows:
- a) Slump:
- i. Maintain a slump moving average, comprised of the average of all batches or most recent five (5) batches tested, whichever is fewer.
- b) Strength test:
- i. Maintain a compressive strength moving average, comprised of three (3) consecutive strength test results, for each mix design used in work.
- ii. Strength level of concrete will be considered satisfactory provided averages of all sets of three (3) consecutive strength test results (i.e. moving average) equal or exceed specified 28-day strength, and no individual strength test result falls below specified 28-day strength by more than 500 psi (3.5MPa).
- iii. If strength tests fail to meet minimum requirements, concrete represented by such tests shall be considered questionable and shall, if deemed appropriate by the SER, be subject to further evaluation by core testing as specified herein or other testing methods.
- iv. Maintain a log that contains the results of all concrete strength tests. The log shall include the results of each test performed, be in electronic spreadsheet format, and updated and submitted along with concrete test data. See example log attached at the end of this Specification Section.
- c) Conduct core tests on questionable concrete in accordance with ACI 318 and ASTM C 42.
- i. Location of cores shall be coordinated with Design Professionals so as to least impair strength of structure. Before testing cores, discard and replace any that show evidence of having been damaged subsequent to or during removal from structure or which have reinforcement present.
- ii. Cores from structure exposed to soil or constant moisture in service (e.g. basement walls, retaining walls, slab-on-grade, piers, footings, etc.) shall be tested in a fully saturated condition. Cores for all other concrete may be tested dry. Prior to commencement of coring, verify with Design Professionals whether cores are to be tested wet or dry.
- iii. Fill core holes with low slump concrete or mortar with a strength equal to or greater than that specified for area cored.

- d) Concrete in area represented by core test will be considered adequate if average strength of cores is equal to at least 85% of, and if no single core is less than 75% of specified strength.
4. Floor flatness and levelness tolerance compliance testing is to be performed within 72 hours of concrete placement by Testing Agency, and prior to the removal of shores and forms.
- A) Testing Agency to test and report flatness (F_F), levelness (F_L) prior to shoring removal. For slabs that include camber, do not test for levelness (F_L). Perform F_F/F_L testing in accordance with ASTM E 1155 requirements.

EXAMPLE CONCRETE STRENGTH SPREADSHEET LOG

PROJECT:
 DATE:
 ARCHITECT:
 STRUCTURAL ENGINEER:

SPECIMEN I.D.	TICKET NUMBER	PLACEMENT LOCATION	MIX I.D.	CURE TYPE *	DATE TESTED	AGE AT TEST (DAYS)	AVERAGE DIAMETER	AVERAGE CROSS-SECTIONAL AREA	BREAKING LOAD (LB)	BREAK TYPE **	AVERAGE COMPRESSIVE STRENGTH
S0002	1234	First Floor Slabs and Beams	H3651	I, CA, CB	3/8/2106	7	4	12.56	165990	Type 1	13210
						14					
						28					
						56					

*FIELD CURING CONDITIONS: NCB=NO CURING BOX, CB=CURING BOX, I=INSULATED, CO=COOLED, HE=HEATED, CA=CAPPED, IC=ICED, O=OTHER

**BREAK TYPES (AS CLASSIFIED BY ASTM C39):



3.5 STRUCTURAL STEEL

A. Quality Assurance:

1. Shop inspection shall include alignment and straightness of members, camber, preparation for connections, dimensional checks, testing of shop bolts, witnessing of welding procedures, testing of cuts, weld access holes and copes of Heavy Sections as defined in this Specification, examination and testing of completed welds, headed studs and deformed bar anchors, cutting of Heavy Sections, finishing of column ends, cleaning, painting and storage of material. All shop fabrication shall be inspected in the shop. Camber shall be verified in a minimum of 10% of all members requiring camber. If, in the opinion of the SER and Testing Agency this testing discloses a large ratio (10% or more) of unacceptable cambers, the required percentage of tested cambers may be increased by the SER to 100% at no expense to the Owner. Where testing is required for less than 100% of locations, select test locations at random and throughout the project.
2. Field inspection shall include connections, proper tensioning of bolts, levelness, plumbness and alignment of the frame, conformance to AWS welding methods, examination of surface before welding, examination and testing of completed welds, headed studs and deformed bar anchors and field painting, including touch-up. Where testing is required for less than 100% of locations, select test locations at random and throughout the project.
3. Review the following items in the shop and field:
 - a) Welding certificates, procedures, and personnel
 - b) Stud welding setup and operators; bolting procedure and crew
 - c) Bolting procedure and crew
 - d) Mill certifications for compliance with the Contract Documents.
4. Inspect high strength bolted construction in accordance with RCSC "Specification for Structural Joints using ASTM A 325 or A 490 Bolts," including but not limited to:
 - a) Surface preparation and bolt type conforms to plans and Specifications prior to start of bolting operations.
 - b) Proper bolt storage and handling procedures per codes and standards referenced by this Specification are being followed.
 - c) Visually inspect all bolted connections.
 - d) For all bolted connections that are indicated as snug tight, connections are properly compacted and brought to the snug tight condition progressing outward from the most rigid part.
 - e) For all bolted connections that are indicated as pretensioned or slip critical, pre-installation verification testing is performed by the inspector in cooperation with the contractor in accordance with RCSC section 9.2 and section 7.
 - f) For all bolted connections that are indicated as pretensioned or slip critical, through routine observation, as defined in RCSC 9.2.1, 9.2.3 or 9.2.4, that the pretensioning methods of RCSC 8.2.1, 8.2.3, or 8.2.4, as appropriate, are performed.

- i. "Routine observation" is defined as observation of 10 bolts for every 100 bolts with a minimum of 2 bolts per connection.
 - g) Retest bolted connections that fail initial inspection after correction by the Fabricator or Erector.
5. Test and inspect welding and welded construction including but not limited to:
 - a) Review of submittals:
 - i. Review all Welding Procedures prepared by the Contractor's Engineer or Certified Welding Engineer. Verify the accuracy of all essential variables of the Welding Procedure including but not limited to confirmation that weldability and heat induction for Heavy Sections and high restraint welds comply with AWS requirements.
 - ii. Review of welding procedures including prequalification, qualifications test and, for Heavy Sections and High Restraint Welds, the welding procedure prepared by the Contractor's Engineer or Welding Consultant
 - iii. Submit for record a report indicating that the Welding Procedures have been reviewed as indicated above to the Design Professionals.
 - b) Test all complete joint penetration welds for soundness by means of either radiographic or ultrasonic testing in accordance with AWS D1.1 and ASTM E164 procedures. All flaws in plate or flange material revealed during such tests shall be repaired and retested by the Contractor at the Contractor's expense.
 - c) Test all partial joint penetration welds for soundness by means of visual and magnetic particle inspection, unless other methods are specified in the Contract Documents. All flaws in plate or flange material revealed during such tests shall be repaired and retested by the Contractor at the Contractor's expense.
 - d) Testing of welds at Heavy Sections and High Restraint Welds shall be performed not less than 48 hours after the weld has been completed.
 - e) Visually inspect all fillet welds. In addition test ten percent (10%) of all fillet welds using a non-destructive method, such as dye penetrant or magnetic particle. Select test locations randomly throughout the structure, but test at least one weld in each location with 6 or more welds per connection. If, in the opinion of the SER and Testing Agency this testing discloses a large ratio (10% or more) of unacceptable welds, the required percentage of tested welds may be increased by the SER to 100%, all at the Contractor's expense.
 - f) Inspection and Testing by the Testing Agency of High Restraint Welds and where Heavy Sections are to be joined by partial or complete joint penetration welds in tension:
 - i. Joint Preparation: Monitor fit up and joint preparation (bevel angle, etc.) for conformance to the submitted welding procedures including preheat and interpass temperature. Monitor base metal temperature during welding operations.

- ii. Test Complete Joint Penetration Welds in accordance to the requirements of this Specification section, ultrasonically in accordance with AWS D1.1 procedures. On T or corner joints, pay careful attention to the heat affected zone and base metal where the weld shrinkage stresses are in the through thickness direction.
 - iii. Test Partial Joint Penetration Butt Joints in accordance with this Specification section by the magnetic particle method. At T or corner joints, in addition to the magnetic particle testing, ultrasonically scan the heat affected zone and adjacent base metal from face "C" per AWS D1.1 Table 6.7 and Annex Q7 to detect lamellar tears and shall be done with a compression wave. The Testing Agency shall submit a testing procedure that includes evaluation (acceptance criterion) procedures to the Design Professionals for review.
- g) At Heavy Sections and High Restraint Welds: provide pre-production sample testing of heat treatment, observe fabrication, welding and heat treatment of the samples for conformance with submitted welding procedures. Establish locations of testing coupons following AWS procedures. Test coupons following AWS procedures to verify satisfactory results using the welding procedure and heat treatment.
6. Visually inspect all headed studs and deformed bar anchors for complete fusion and full 360-degree weld flash (or fillet).
- a) Check all studs with incomplete fusion, and at random five studs at each of six beams per floor, by bending to an angle of 15 degrees from its original axis (away from any missing flash). If more than twenty percent of studs fail on one member, check all studs on member. In addition, for each member with any defective studs, test an additional member.
 - b) Contractor to replace any studs that crack or break. Contractor to only straighten studs that would foul other work or have less than 1 inch (25mm) cover in bent position.
7. Cleaning & Painting:
- a) Examine shop painting to verify conformance with this Specification.
 - b) Examine loading and unloading of steel to visually observe that damage does not occur during shipping and handling.

3.6 FOOTINGS

A. Quality Assurance by Geotechnical Engineer (or Testing Agency if the same entity):

1. Review Contractor's proposed footing installation methods, sequences, and procedures.
2. Verify bearing stratum and bearing capacity of each footing; verify levelness of footing end bearing surface.
3. Determine final bearing elevation at each footing location.
4. Observe, record, and report footing as-built plan location, footing size and final elevations of bottom (where possible) and top of completed footings.
5. Coordinate with Testing Agency.

B. Quality Assurance by Testing Agency:

1. Inspection of Batch Plant: As required to ensure that concrete delivered to job complies with Specifications and design mix. Batch plant inspection shall be required once at start of job and thereafter if concrete falls below Specifications.
2. Inspection of Reinforcement: Provide continuous visual inspection of site fabrication. Record the steel reinforcement bar sizes, grade, length, and number of bars.
3. Inspection of Concrete and Reinforcement Placement: Provide continuous visual inspection of installation of reinforcement and concrete placement including verification of laitance removal at top of footings.
4. Check ready mix delivery tickets for correct concrete mix design number. Record batch to placement time. Check slump, temperature, and batch to placement time for each set
5. Slump Tests: ASTM C143. Make one test from each truck.
6. Concrete Compressive Strength Tests: Testing agency will take a minimum of one sample set of concrete cylinders per 20 cubic yards of concrete. See CAST-IN-PLACE CONCRETE section of this specification for requirements. Cure cylinders to simulate same curing conditions as concrete in footings. Reports of cylinder tests shall state footing location(s), laboratory or site curing, compression strength, type of fracture, age at testing, concrete supplier, mix specification strength, any other pertinent information, test results, and conclusions.
7. Additional Tests: Perform additional testing if, in the opinion of the Design Professionals, concrete of poor quality has been placed based on cylinder strengths below Specification requirements or visual defects. Tests may be compression tests on cored cylinders, ASTM C42, and load tests as outlined in ACI 318, or as directed by the Design Professionals. Complete continuous coring of footings will be required, at Contractor's expense, where verification of quality of concrete is not otherwise attainable.

3.7 STEEL PILES

A. Quality Assurance:

1. Testing Agency shall have a minimum of five years of experience in dynamic pile testing and analysis. The Testing Agency shall perform dynamic measurements and analysis on test piles in general accordance with ASTM D 4945.
2. Review Specification Section 316216 for the number of test piles and sequence of operations.

3. Review and become familiar with the Geotechnical Evaluation Report recommendations regarding piles.
4. Inspect steel piles including alignment and straightness of piles, and storage of material.
5. Review mill certifications for compliance with the Contract Documents.

3.8 AUGER CAST-IN-PLACE PILES

A. Quality Assurance by Geotechnical Engineer (or Testing Agency if the same entity):

1. Prepare a pile report sealed and signed by a Professional Engineer licensed in the state where the project is located, including the following:
 - a) Date of installation.
 - b) Pile number, size, and location of pile referenced to building grid lines.
 - c) Indicate condition of top of pile for inclusion of debris and foreign matter.
 - d) Description of soil strata materials.
 - e) Description, location, and dimensions of obstructions.
 - f) Ground-water conditions
 - g) Date and time of start and completion of drilling and grouting.
 - h) Position of centralizers
 - i) Locations of construction joints (if any)
 - j) Unusual occurrences encountered in drilling operation
 - k) Grout testing results
 - l) Reinforcing steel layout
 - m) Confirmation of use of required grout design mixture
 - n) Grout placement, including conveying and depositing
 - o) Record rate of pumping, volume of grout per pile, and observed pressures during the grouting process
2. If any pile is deemed unsatisfactory, direct the Contractor to re-drill and re-grout the pile in-place while the grout is still in a fluid state.

B. Quality Assurance by Testing Agency:

1. Inspect in conformance with provisions of document entitled "Draft Guide to Inspection of Augured Cast-in-Place Piles," by Deep Foundations Institute, Committee on Augured Cast-in-Place Piles, dated February 1993.
2. Provide continuous visual inspection of site fabrication. Record the steel reinforcement cage bar sizes, grade, length, and number of bars and tie spacing, prior to placement into the shaft. Record use of spacers and/or centralizers..
3. Test the grout mix by making one set of 2 in. (50 mm) cubes in accordance with ASTM C109-05 and C 942 for each 100 cy (75 cubic meters) of grout placed. However, as a minimum at least one set shall be made for each day during which piles are installed. A set of cubes shall consist of a total of six (6) cubes: 2 cubes to be tested at 7 days and two (2) cubes to be tested at 28 days. The remaining two 2 cubes will be held in reserve and tested at a later date, if required. Obtain samples after batching, adding water, and adding other ingredients. Cube specimens may be restrained from expansion as described in ASTM C942.
4. Test each batch of grout sampled using the Flow Cone Test ASTM C939-02, with a flow cone fitted with a ¾ in. diameter outlet. Maintain grout fluidity of between 15 and 25 seconds. Test the slump flow under the provisions of ASTM C 1611.

END OF SECTION 014500

SECTION 01 5639 - TEMPORARY TREE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general protection and stress mitigation of existing trees to be preserved that are affected by execution of the project activities, whether temporary or permanent construction.
- B. The following specifications adhere to activities involving the preservation and stress mitigation measures and coordination and supervision of the Tree Preservation Plan by the General Contractor. This work includes, but is not limited to the following:
 - 1. Installation of tree preservation measures
 - 2. Root Pruning
 - 3. Tree Protection Fencing and signage
 - 4. Temporary Root Matting
 - 5. Vertical Mulching
 - 6. Growth Regulator Treatments
 - 7. Monitoring and Reporting of tree conditions during construction.

1.2 DEFINITIONS

- A. Certified Arborist: Credential of individual accredited by the International Society of Arboriculture
- B. Common Name: The name by which a plant species is commonly known. Will be indicated on the Plans and Tree Inventory

- C. Condition Rating: Health ratings of a tree during the time of inventory as assessed by the Consulting Certified Arborist. Ratings are Good, Fair, Poor, and Dead, or as a combination of these such as “Good/Fair.”
- D. Contract Arborist: Tree service company contracted to implement the tree preservation plan.
- E. Critical Root Zone (CRZ): Depicted as dashed circles on the plans to indicate trees and their potential tree root locations within proximity of this project. CRZ is determined by measuring the main stem 4.5’ above the ground, then providing 1.5 feet of protection (radius of circle) for every one inch in tree diameter.
- F. Diameter at Breast Height (DBH): Tree trunk diameter as measured at 4.5’ above the ground
- G. Growth Regulator Treatment: Chemically treat the trees slated for construction stress mitigation per the manufacturer recommendations at an appropriate time of year.
- H. Limits of Disturbance (LOD): Limits of all construction activities for the project.
- I. Project Arborist: Consulting Certified Arborist firm contracted to provide planning and design assistance before, during, and post construction.
- J. Root Pruning: If / when necessary, pruning of roots by cutting roots flush to limit wound surface area and shall be performed by first hand-digging or SSAT excavation, then using hand tools only to sever the roots. Work shall be performed by or under the direct supervision of a Certified Arborist.
- K. Supersonic Air Tool (SSAT): pneumatic air tool used to excavate the surrounding soil without damaging large roots.
- L. Temporary Root Matting: A system of a double-sided geotextile with a geonet core installed at the grade and anchored into place using landscaping pins or anchors, then 6” of woodchips or mulch placed on top of that. If heavy machinery is to be used in these locations, a layer of 3/4” plywood or Track Mats shall be placed on top of that to evenly distribute the weight of the machine tires or tracks.
- M. Tree Protection Fencing: Fencing installed to create a physical barrier to protect the trees and their roots from pedestrian and machine access and stockpiling of materials within the Tree Protection Zone.
- N. Vertical Mulching: Tree Preservation measure utilized to mitigate soil compaction using SSAT and backfilled with organic and nutrient rich soil.

1.3 PRE-CONSTRUCTION MEETINGS

- A. Arborist Pre-construction meeting – Before the Project may proceed, a meeting to discuss the approved tree preservation plan must be conducted. The meeting shall be held with the Project Arborist, Contract Arborist, Design Team, SI Representative, and NPS Arborist in attendance.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and locations of tree protection fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
- C. Samples: For each type of the following:
 - 1. Biochar (or approved equal): Sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
 - 2. Tree Protection Zone Fencing: Assembled Samples of each fencing type including Tree Protection-Zone Signage. $\geq 10'$ length. Mock-up is acceptable.
 - 3. Tree Protection Zone Signage: Full-size Samples.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification: From Project 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.
- B. Maintenance Recommendations: From Project arborist, for care and protection of trees affected by construction during and after completing the Work.
- C. Existing Conditions: Documentation of existing trees indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1.6 QUALITY ASSURANCE

A. Arborist Qualifications:

1. Project Arborist - Certified Arborist as certified by ISA, licensed arborist in jurisdiction where Project is located.
2. Contract Arborist – Certified Arborist as certified by ISA, licensed arborist in jurisdiction where Project is located, and accreditation as a Licensed Tree Expert
 - a. Submit a resume and detailed qualifications from staff assigned to this project.
 - b. Provide (3) references for projects similar in size and complexity to illustrate competency in successfully implementing the tree preservation measures outlined in the tree preservation plans. Include the following information:
 - 1) Project Name, size, and scope
 - 2) Number and species of trees involved
 - 3) Relevant photos or plans
 - 4) Scope of services provided
 - 5) Name and contact for project owner, designer, or contractor

1.7 FIELD CONDITIONS

A. The following practices are prohibited within tree protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment. If / when necessary within Temporary Root Matting, consult the Project Arborist prior to implementation to discuss means and methods, weight of equipment, and duration.

3. Foot traffic (Temporary Root Matting foot traffic is acceptable).
 4. Impoundment of water.
 5. Excavation or other digging unless otherwise indicated.
 6. Concrete washout or overpour
 7. Disposal of waste materials, such as paint and cleaning chemicals.
- B. Do not direct vehicle or equipment exhaust toward tree protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near tree protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Vertical Mulching Biochar: Carbon rich charcoal-like substance made from organic sources.
- B. 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 mulch or woodchips.
- C. Tree Protection Fencing: Fencing fixed in position and meeting the following requirements:
1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.148-inch-diameter wire chain-link fabric; with 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 and 0.177-inch-diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
 - a. Height: 72 inches.

- b. Posts made from metal piping
- D. Tree Protection Zone Signage: Shop-fabricated, weatherproof, rigid plastic or metal sheet with attachment holes pre-punched and reinforced; legibly printed with nonfading lettering.
- E. Temporary Root Matting: While working on the existing asphalt, no root protection is needed. If the asphalt is removed and the soil and roots are exposed, foot traffic only is permitted in exposed areas. For equipment with 4.4 PSI of ground pressure, Altarnamats (or equal) suffice, use appropriately sized turf/soil protection mats for these activities. Heavier loads will require more protection, e.g., 6-8" bed of woodchips, heavier soil protection mats, or a combination of both.

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 and are trench-less. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree protection zones.

3.2 PREPARATION

- A. Contact the Project Arborist at least seven (7) days prior to performing work which requires Arborist supervision.
- 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.

3.3 TREE PROTECTION ZONES

- A. Tree Protection Zone Fencing: Install protection-zone fencing along edges of tree protection zones in a manner that will prevent people from easily entering protected areas except by entrance gates.
 - 1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.

2. Posts: Posts made from metal piping, with sharp, blemish free bottoms may be driven with ability to cut roots. Post extraction shall be mindful to lift straight out to keep from compacting soil in walls of post holes. Adjust post location to avoid tree roots, as necessary. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
- B. Tree Protection Zone Signage: Install tree protection-zone signage in visibly prominent locations in a manner approved by Architect.
 - C. Maintain tree protection zones free of weeds and trash.
 - D. Maintain tree 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.

3.4 ROOT PRUNING

- A. Under the direct supervision of the Project Arborist, prune tree roots that are affected by temporary and permanent construction if / when it becomes necessary.
 1. Cut roots manually by digging a trench or by SSAT excavation 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. Prune roots flush and perpendicular to form.
 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 3. Cover exposed roots with burlap and water regularly.
 4. Backfill as soon as possible
- B. Root Pruning at Edge of Tree Protection Zone: Under the direct supervision of the Project Arborist, prune tree roots by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Tree Protection Zone: Under the direct supervision of the Project Arborist, clear and excavate by hand or with SSAT to the depth of the required excavation to minimize damage to tree root systems. Cleanly cut roots as close to excavation as possible, and perpendicular to form.
- D. Engage an ISA qualified arborist to perform root pruning.

3.5 CROWN PRUNING

- A. If / when canopy pruning becomes necessary. The pruning work must be performed under the direct supervision of the Project Arborist, prune branches that are affected by temporary and permanent construction. Prune branches as directed by Arborist.
 - 1. Prune to remove only broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
 - 2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
 - 3. Pruning Standards: Prune trees according to ANSI A300 (Part 1). Sanitize cutting tools after each cut with isopropyl alcohol or a diluted bleach solution as American Elm trees are highly susceptible to the spread of Dutch Elm Disease.
 - 4. No tree pruning or tree manipulation without approval of NPS Arborist/Urban Forester.
- B. Engage an ISA qualified arborist to perform crown pruning.

3.6 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the tree protection zone. Maintain existing grades within the tree protection zone.
- B. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the tree protection zone. Maintain existing grades within the tree protection zone.
- C. Minor Fill within Tree 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.

3.7 FIELD QUALITY CONTROL

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

- B. A Certified arborist (Contract Arborist) shall be on site at all times overseeing work performed during any activities or soil disturbance within the Critical Root Zone (CRZ).
- C. No tree pruning or tree manipulation is permissible without approval of NPS Arborist/Urban Forester.

3.8 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. Perform repairs of damaged trunks, branches, and roots within 24 hours according to Arborist's written instructions.
 - 2. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect. Tree replacement shall be tagged by NPS Urban Forester or representative at growers facility.
 - a. Tree removals shall be performed by a contractor accredited as a Licensed Tree Expert and must have an ISA Certified Arborist present onsite while the work is being performed.
 - b. Stump grinding depth shall be 24" inches below grade or once through the bottom of the stump. The contractor is responsible for coordinating utility markings for each stump.
 - c. ALL (100%) shavings/grinded stump and root material shall be removed from the stump hole. All surface roots 1" diameter and larger shall be ground. The stump site shall be backfilled with a soil mixture to meet the following specifications in (B). A certificate from the topsoil provider shall be supplied to the COR prior to installation.
- B. Replacement Soils: Shall be a screened, natural, surface soil, in a friable condition and contain less than 3 percent subsoil. The topsoil shall be free of hardpan material, stones and clods larger than 1/2 inch in diameter, sticks, tree or shrub roots, debris, toxic substances (i.e. residual herbicides) and other material detrimental to plant growth. The area and the topsoil shall be free of undesirable plants or plant parts such as, but not limited to, bermudagrass, nut sedge, mugwort, Johnson grass, quack grass, Canada thistle or noxious weeds as set forth in the Federal Seed Act.
 - 1. Contractor shall notify NPS of location of all sources of the topsoil and furnish the NPS a certified report from the agricultural experiment station or approved agricultural laboratory of an analysis performed not more than 60 days prior to the date of submission. The topsoil shall be certified to meet the following requirements:

- a. Shall be a natural, original surface soil of a sandy loam texture with a mechanical analysis of 50% -65% sand, 15-25% silt and 10-35% clay.
 - b. Shall have at least 2%, but not more than 5%, organic matter.
 - c. Soil pH shall 5.5 to pH 7.2 inclusive unless otherwise specified.
 - d. Soil salinity by electrical conductivity measurement shall not exceed 600 parts per million (ppm) as determined by Black, Editor "Method of Soil Analysis", Part 2, published by the American Society of Agronomy, 1965.
 - e. The soil nutrient level shall be between 70-265 lbs. /acre of magnesium, 65-205 lbs./acre of phosphorous (P2O5), and 85-320 lbs./acre of potassium (K2O).
 - f. Agricultural limestone at not more than 5 pounds per cubic yard of topsoil may be used to adjust an acidic condition and shall be thoroughly mixed by volume.
 - g. Topsoil which has been synthesized by blending materials which individually do not meet the requirements of this specification will not be accepted even though the resulting blend meets the organic matter, mechanical analysis, Ph and soluble salts requirements.
 - h. Topsoil shall not be delivered or handled in frozen or muddy conditions.
- C. Tree replacement shall be a 2.5" (2" min – 3" max) caliper Jefferson Elm from a verified source.
1. Replacement tree shall be free of visual defects to the roots, shoot, and canopy.
 2. Tree replacement soil moisture shall be monitored by an ISA Certified Arborist monthly from May through September using a hydrometer or approved equal during its first year of installation.
 - a. Soil moisture for replacement tree shall be maintained between 7% and 17% Water Holding Capacity (WHC).
 - b. Supplemental watering must be applied if the moisture readings are determined to be too low by the Certified Arborist.

- D. 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 uniform thickness to remain.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 01 5639

SECTION 02 4113 - SELECTIVE SITE DEMOLITION

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. Provide labor, materials and equipment as necessary to complete work as indicated on the Drawings and specified herein.
- B. This section includes the removal of existing structures, fences, pavements, and other items indicated on the drawings or specified, or both.
- C. Related Sections:
 - 1. Division 01 Section "Supplementary Conditions for Construction" for:
 - a. restrictions on the use of the premises
 - b. for protection requirements
 - c. for administrative requirement for salvaging, recycling and disposing of nonhazardous demolition and construction waste.
 - 2. Division 01 Section "Temporary Tree Protection" for protection and stress mitigation of existing trees.
 - 3. Division 31 Section "Earthwork" for excavation and utility trenching.

1.3 PROJECT CONDITIONS

- A. Do not close or obstruct streets, walks or other occupied or operational facilities without permission from the COTR. Provide alternate routes around closed or obstructed traffic ways if required.

PART 2 – PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor to verify that utilities have been disconnected and capped before starting selective demolition operations.

1. Modify existing temporary utilities to maintain coverage.
- B. Survey of Existing Conditions: Record existing conditions by use of photographs prior to demolition.
 1. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to the Architect and COTR.

3.2 PREPARATION

- A. Prior to commencement of the work of this Section in each area of work, inspect that area thoroughly. Notify the COTR of any unsatisfactory conditions. Do not proceed until unsatisfactory conditions are corrected as directed by the COTR.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with hallways, elevators, roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Comply with requirements for access and protection specified in Division 01 Section "Supplementary Conditions for Construction"
- C. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 3. Cover and protect site furnishings that have not been removed.

3.3 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
- B. Remove all existing site work as indicated on the drawings.
 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

- a. Saw edges of concrete removed flush with adjacent concrete to remain.
 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 3. Remove deteriorated, decayed, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 4. Support all materials, mechanical and electrical systems that are to remain. Attached to the existing structural framing as necessary.
 5. Dispose or salvage demolished items and materials promptly.
- C. Demolish concrete in small sections. Using power-driven saw, cut concrete to a depth of at least 19 millimeters at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove the remainder of concrete. Neatly trim openings to dimensions or to align as indicated in the contract documents.
- D. Remove masonry in small sections. Cut masonry out along mortar joints in toothed pattern and remove with hand tools.
- E. In the event of demolition of items not scheduled to be demolished, promptly replace such items to the approval of the COTR at no added cost to the owner.

3.4 CLEAN-UP

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 4113

SECTION 031000 - CONCRETE FORMWORK

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

Provide all labor, materials, equipment, services and transportation for formwork and related accessories required to complete all cast-in-place concrete work as shown on Drawings, as specified herein, and as required by the job conditions.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 014500
Concrete Reinforcement and Embedded Assemblies	Section 032000
Cast-In-Place Concrete	Section 033000
Thermal and Moisture Protection	Division 7

1.4 CODES AND STANDARDS

- A. Building Code: Concrete work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.
- B. Standards:
1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
 2. ACI 237 – Self Consolidating Concrete.
 3. ACI 301 – Specifications for Structural Concrete.
 4. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.
 5. ACI 347 – Guide to Formwork for Concrete.
 6. ACI 347.2R – Guide for Shoring/Reshoring of Concrete Multistory Buildings
- C. Definitions:
1. See Section 033000.

1.5 CONTRACTOR QUALIFICATIONS

- A. The work of this section shall be performed by a company specializing in the type of concrete formwork required for this Project, with a minimum of 10 years of documented

successful experience and shall be performed by skilled workers thoroughly experienced in the necessary crafts.

- B. Contractor's testing agency Services: Required as specified in Division 1, and herein.
- C. Materials and installed work may require testing and retesting at any time during progress of work, as directed by Design Professionals. Tests, including retesting of rejected materials for installed work will be done at Contractor's expense.

1.6 SUBMITTALS

- A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested.

- (1) Submittal Schedule
- (2) Shop Drawings
- (3) Shoring/Reshoring Calculations
- (4) Product Data
- (5) Samples
- (6) Compatibility Certification
- (7) Hazardous Materials Notification

1. **Submittal Schedule:** See Section 033000.

2. **Shop Drawings:**

- a) Submit for action: Formwork shop drawings sealed and signed by a Professional Engineer licensed in the state where the project is located. Shop drawings shall clearly indicate but not be limited to the following:
 - 1. Size, type and quality of form materials including conditions at tops and ends of walls. (If wood is used, indicate species.)
 - 2. Form construction indicating structural stability and jointing including special form joints or reveals required by Contract Documents
 - 3. Location and pattern of form tie placement, and other items that affect the appearance of concrete that will remain exposed to view.
 - 4. Form finish clearly indicating proper locations and full coordination with concrete finishes required by Contract Documents.
 - 5. Layout, procedures, and sequencing of shoring and reshoring that correlates with the information contained in the shoring/reshoring calculations described below.
 - 6. Locations and dimensions of openings in structural members including floor slab, shear walls, columns and beams. See SUBMITTALS Section of Specification 033000.
 - 7. Location of proposed construction joints in walls, floors, slabs, and beams. See SUBMITTALS Section of Specification 033000.

3. **Shoring/Reshoring Calculations:** Submit for record. Calculations sealed and signed by a Professional Engineer licensed in the state where the project is located. Calculations shall clearly address but not be limited to the following:
 - a) Shoring removal and reshoring installation procedure including timing and sequencing.
 - b) Concrete age and strength at the time of each shoring/reshoring operation.
 - c) Description of construction loads assumed including concrete, formwork, and construction live load in accordance with ACI 347.
 - d) Description of the distribution of construction loads between the shored/reshored levels.
 - e) The total construction load imposed on all levels supporting shoring/reshoring at each stage of the shoring/reshoring cycle.
 - f) A written statement by the Professional Engineer that the total construction load imposed on any level supporting shoring/reshoring, at all stages of the shoring/reshoring cycle, accounting for concrete age and relative strength at time of loading, meets the requirement of Section 3.2.
4. **Product Data:** Submit for action copies of manufacturers' product data and installation instructions for proprietary materials used in exposed concrete work, including form liners, release agents, manufactured form systems, ties, and accessories.
5. **Samples:** At request of Architect, submit for record samples of form ties and spreaders.
6. **Compatibility Certification:** Submit for record a written statement certifying that form release agent used is compatible with subsequent architectural finish materials applied to concrete surfaces. Submit along with manufacturer's data.
7. **Hazardous Materials Notification:** Submit for record. In the event no product or material is available that does not contain hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

- B. Submittal Process: See Section 033000.
- C. SER Submittal Review: See Section 033000.
- D. Substitution Request: See Section 033000.
- E. Request for Information (RFI): See Section 033000.

1.7 FORMWORK DESIGN

- A. Design of Formwork, Shoring/Reshoring, and its removal is the Contractor's responsibility.
- B. Design, erect, support, brace and maintain formwork so that it will safely support vertical and lateral loads per SEI/ASCE 37-02 that might be applied, until such loads can be supported by the concrete structure.
- C. Design Requirements:
 1. Forms shall be designed for fabrication and erection in accordance with Design Professionals' requirements and recommendations of ACI 301, 318 and 347.

2. Design formwork in a manner such that the total construction load does not at any time exceed the total design load of new or existing construction and accounts for concrete age and relative strength at time of loading. See Section 3.2 for shoring/reshoring requirements.
3. Design formwork for loads and lateral pressures outlined in Section 2.2, ACI 347, and wind and seismic loads as specified by SEI/ASCE 37-02 unless otherwise controlled by local building code.
4. Design formwork to include loads imposed during construction, including weight of construction equipment, concrete mix, height of concrete drop, rate of filling of formwork, vibrator frequency, ambient temperature, foundation pressures, lateral stability, temporary imbalance or discontinuity of building components, and other factors pertinent to safety of structure during construction.
5. The use of flowing concrete (8" (200mm) to 10" (250mm) slump) or Self-Consolidating Concrete requires a review of the formwork design based on the rate of placement and setting time of the mix. Unless shown to be sufficient otherwise, formwork design shall conform to the requirements of ACI 237.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with General Conditions and Division 1, including the following:
 1. Store forms and form materials clear of ground and protect from damage.

1.9 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. See Section 014500.

1.10 QUALITY CONTROL BY CONTRACTOR

- A. See Section 033000.

1.11 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

- A. See Section 033000.

1.12 PERMITS AND WARRANTY

- A. Permits: See Section 033000.
- B. Warranty: See Section 033000. Failures include but are not limited to the following:
 1. Discoloration of concrete scheduled to remain exposed to view.
 2. Damage of concrete finishes caused by forms.
 3. Damage of concrete caused by form stripping.
 4. Non-compliance with form finishes required for designated architectural finishes.
 5. Non-compatibility of form release agent with subsequent architectural finish materials applied to concrete surfaces.
 6. Excessive and/or noticeable bowing in placed concrete members caused by deflection of formwork during concrete placement.

PART 2 - PRODUCTS

2.1 FORMWORK REQUIREMENTS

A. General Requirements:

1. Formwork shall meet construction safety regulations for the state where the project is located.
2. Forms shall be removable without impact, shock or damage to concrete surfaces, the structure and adjacent materials.
3. Forms shall be tight-fitting, designed and fabricated for required finishes and to withstand concrete weight and maintain tolerances as specified in ACI 117 for the following designations: (See architectural drawings for locations).
 - a) Class A – For surfaces prominently exposed to public view where appearance is of special importance.
 - b) Class B – Coarse-textured concrete-formed surfaces intended to receive plaster, stucco or wainscoting.
 - c) Class C – General Standard for permanently exposed surfaces where other finishes are not specified.
 - d) Class D - Minimum quality surface where roughness is not objectionable, usually applied where surfaces will be concealed.
4. Furnish forms in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings, using form materials with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.
5. Butt Joints: Shall be solid and complete with backup material to prevent leakage of cement paste.

B. Form Finishes for Exposed Surfaces:

1. Type: Straight, smooth, free of cement paste leaks at butt-joints, surface imperfections and other irregularities detrimental to appearance of finished concrete, fully coordinated with requirements for required finish material.
2. Form exposed areas of columns, beams, ledges, balcony fascias to achieve true alignment and level soffit of edge beams and concrete edges. All such areas must be sharp, straight and true to line and level. Edge beams and concrete canopies and ledges must have adequate shoring to prevent any visible amount of sag and sufficient bracing to prevent any lateral movement during construction.

2.2 FORM MATERIALS

A. General: Plywood, fiberglass, metal, metal-framed plywood faced, or other acceptable panel-type materials.

1. Provide materials with sufficient strength to prevent warping.

B. Plywood: Of species and grade suitable for intended use, sound undamaged sheets with clean true edges, minimum 5/8" (16mm) thick, complying with U.S. Product Standard PS-1.

1. Other Acceptable Sheet Materials: 14 gauge (2.0mm) sheet steel or fibrous glass reinforced resin.

- C. Lumber: Construction grade or better consistent with calculation requirements, without loose knots or other defects.
1. Use only where entire width can be covered with one board 11-1/4" (285mm) or less in width.
- D. Forms for Cylindrical Columns and Supports: Metal, glass-fiber reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications.
1. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
- E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to support weight of placed concrete without deformation.
- F. Chamfer for Form Corners:
1. Types: Chamfer strips of wood, metal, PVC or rubber fabricated to produce smooth form lines and tight edge joints, 3/4" (20mm) size, maximum possible lengths.
 2. Required for all exposed corners of beam, walls and column forms.
- G. Form Ties:
1. Type: Factory-fabricated metal, adjustable length, designed to prevent form deflection and to prevent spalling concrete upon removal.
 2. Ties used for architecturally exposed concrete shall be galvanized.
 3. Ties shall not leave metal closer than 1-1/2" (40mm) to exposed surface.
 4. When removed, ties shall not leave holes larger than 1" (25mm) diameter in concrete surface.
 5. Removable Ties: Use type with tapered cones, 1" (25mm) outside diameter, for concrete walls which will remain exposed to view and scheduled for architectural finishes.
 6. Snap-Off Ties: Use for concrete walls below grade and walls which will not remain exposed to view and are not scheduled for architectural finishes.
 7. Wire Ties: Not acceptable.
- H. Nails, Spikes, Lag Bolts, Thru-Bolts, Anchorages:
1. Type: Of size, strength and quality to meet the required quality of formwork.
- I. Form Release Agent:
1. Type: Commercial formulation form release agent of non-emulsifiable type which will not bond with, stain, or adversely affect concrete surfaces. Form release agent shall not impair subsequent treatment of concrete surfaces requiring bond or adhesion, or impede the wetting of surfaces to be cured with water or curing compounds. Form release agent shall be compatible with subsequent architectural finish materials applied to concrete surfaces. Apply in compliance with manufacturers' instructions.
 2. Form release agent shall meet, at a minimum, all federal and state requirements for volatile organic compounds (VOC's).
 3. For Steel Forms: Non-staining rust-preventative type.

- J. Reglets: Provide sheet metal reglets formed of same type and gauge as flashing metal, unless indicated otherwise on Drawings. Where resilient or elastomeric sheet flashing, or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gauge (0.55mm) galvanized sheet metal. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- K. Coordinate with materials as specified in Section 032000 Concrete Reinforcement and Embedded Assemblies.

PART 3 - EXECUTION

3.1 FORMWORK

A. General:

1. Inspect areas to receive formwork.
2. Construct forms to sizes, shapes, lines, and dimensions shown on Contract Documents, and to obtain accurate alignment, location, grades, level and plumb work in finished structures.
3. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins, and to maintain alignment.
4. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, drips, bevels, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other features required in the Work.
5. Comply with shop drawings, ACI 301, 318, 347 and Contract Documents.
6. Maintain formwork and finished work construction tolerances complying with ACI 301 and 117.
7. Provide shore and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof.
8. Erect forms for easy removal without hammering or prying against concrete surfaces.
9. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.
10. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only.
11. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
12. Chamfer exposed corners and edges as indicated on the architectural drawings, using wood, metal, PVC or rubber chamfer strips fabricated to produce smooth lines and tight edge joints.
13. Design, erect, support, brace and maintain formwork and shoring to support loads until such loads can be safely supported by the concrete structure.
14. Where specifically shown on the Contract Documents as monolithic, upturned beams, curbs and similar members in connection with slabs shall be formed so that they can be poured integrally with slabs.

B. Concrete Accessories and Embedded Items:

1. Install into forms concrete accessories, sleeves, inserts, anchor bolts, anchorage devices and other miscellaneous embedded items furnished by other trades or that are required for other work that is attached to or supported by cast-in-place concrete.
 - a) Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached.
 2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
 3. Install dovetail anchor slots in concrete structures as indicated on drawings or required by other trades.
 4. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces.
 5. Coordinate with CONCRETE REINFORCEMENT AND EMBEDDED ASSEMBLIES Section in Specification 032000.
 6. Install accessories and embedded items straight, level, plumb and secure in place to prevent displacement by concrete placement.
- C. Temporary Openings:
1. Locate temporary openings in forms at inconspicuous locations.
 2. For clean-outs and inspection before concrete placement, locate temporary openings where interior area of formwork would otherwise be inaccessible.
 3. For cleaning and inspections, locate openings at bottom of forms to allow flushing water to drain.
 4. Securely brace temporary openings and set tightly in forms to prevent loss of concrete.
 5. Close temporary openings with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be noticeable on exposed concrete surfaces.
- D. Provisions for Other Trades: Coordinate and provide openings in concrete formwork to accommodate work of other trades.
1. Determine size and location of openings, recesses, chases, offsets, openings, depressions, and curbs from information provided by trades requiring such items.
 2. Accurately place and securely support items built into forms.
- E. Cleaning:
1. Normal Conditions:
 - a) Thoroughly clean forms and adjacent surfaces to receive concrete.
 - b) Remove chips, wood, sawdust, dirt, standing water or other debris just before placing concrete.
 - c) Flush with water or use compressed air to remove remaining foreign matter.
 - d) Verify that water and debris can drain from forms through clean-out ports.
 2. During Cold Weather:

- a) Remove ice and snow from within forms.
- b) Do not use de-icing salts.
- c) Do not use water to clean out completed forms, unless formwork and concrete construction will proceed within heated enclosure.
- d) Use compressed air or other means to remove foreign matter.

F. Form Release Agents

1. Before placing reinforcing steel and miscellaneous embedded items, coat contact surfaces of forms with an approved non-residual, low VOC form release agent in accordance with manufacturer's published instructions.
2. Do not allow release agent to accumulate in forms or come into contact with reinforcement or concrete against which fresh concrete will be placed.
 - a) Coat steel forms with nonstaining, rust-preventative material.
3. Remove form release agent and residue from reinforcement or surfaces not requiring form coating.

G. Before Placing Concrete:

1. Inspect and check completed formwork, shoring and bracing to ensure that work is in accordance with formwork requirements of this section and Contract Documents, and that supports, fastenings, wedges, ties, and parts are secure.
 - a) Make necessary corrections or adjustment to formwork to meet tolerance requirements.
2. Retighten forms and bracing before concrete placement to prevent mortar leaks and maintain proper alignment.
3. Notify Testing Agency sufficiently in advance of placement of concrete to allow inspection of completed and cleaned forms.

H. During Concrete Placement:

1. Maintain a check on formwork to ensure that forms, shoring, ties and other parts of formwork have not been disturbed by concrete placement methods or equipment.
2. Use positive means of adjustment as required for formwork settlement during concrete placing operations.

I. Camber:

1. Provide camber in formwork as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads.
2. Camber bottom forms where indicated on the drawings. Whenever forms are cambered, screeded levels for establishing top of concrete must be cambered to the same amount and to the same profiles such that scheduled depth of member is not reduced by lifting of forms. Check camber and adjust forms before initial set as required to maintain camber.

J. Surface Defects:

1. Install forms that will not impair the texture of the concrete and are compatible with the specified finish type.
- K. Formwork Loads on Grade
1. Where loads from formwork bear on grade, provide suitable load-spreading devices for adequate support and to minimize settlement. In no event shall frozen ground or soft ground be utilized directly as the supporting medium.
- L. Footings and Grade Beams:
1. Provide forms for footings and grade beams if soil or other conditions are such that earth trench forms are unsuitable.
 2. When trench forms are used, provide an additional 1" (25mm) of concrete on each side of the minimum design profiles and dimensions indicated.
- M. For slabs-on-grade, secure edge forms in such a manner as to not move under weight of construction loads, construction and finishing equipment, or workers.

3.2 SHORES AND RESHORES

- A. Comply with ACI 347.2R for shoring and reshoring in multistory construction, and as specified herein.
1. For non-post tensioned flat plate concrete structures of five supported levels or more, extend shoring/reshoring at least four levels below the floor or roof being placed (shore formwork, reshore three levels below)
 2. For non-post tensioned flat plate concrete structures of less than five supported levels, extend shoring/reshoring to ground.
 3. For all other concrete structures of four supported levels or more, extend shoring/reshoring at least three levels below the floor or roof being placed (shore formwork, reshore two levels below)
 4. For all other concrete structures of less than four supported levels, extend shoring/reshoring to ground.
 5. Reshores shall be placed as soon as practicable after stripping operations are complete but no later than the end of the working day in which the stripping occurs.
 6. For shoring/reshoring placed on mud sills, adjustments shall be made by contractor to account for ground settlement.
 7. Locate shores/reshores such that the factored (ultimate) construction load imposed onto any slab or beam at any time during the construction cycle does not exceed 90% of the factored (ultimate) design load for that slab or beam, scaled down to reflect effect on capacity of lower concrete strength at time of loading.
 8. Construction load shall include the weight of wet concrete, total weight of formwork and shoring/reshoring, and a minimum construction live load of 50 psf (2.5kPa) (increase if construction operations will produce higher loading). Design load includes self-weight of the slab, and superimposed dead and live loads as indicated on the drawings.
 9. For comparison of construction loads to design loads, compare factored (ultimate) construction loads to factored (ultimate) design loads. For construction dead and live loads, use the same load factors and load combinations as required by ACI 318 for design dead and live loads. The specified strength reduction factors from ACI

318 should also be applied during the strength evaluation of the partially completed structure.

10. For flat plate or flat slab construction “backshores” or “preshores” as defined in ACI 347 shall be permitted only if appropriate calculations and construction sequences are provided demonstrating that the accumulation of shore loads will not overload any slab. In the absence of such calculations and construction sequences, shores must be removed and reshores installed in a sequence such that each floor is permitted to deflect and carry its own weight prior to the installation of reshores.
11. Reshores shall not be removed until the concrete has attained its specified 28 day strength.

3.3 REMOVING FORMS

- A. Formwork not supporting the weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 12 hours after placing concrete, provided concrete is sufficiently hard to avoid damage by form-removal operations, and provided curing and protection operations are maintained after removal of formwork.
- B. Formwork supporting the weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed until concrete has attained at least 75% of design compressive strength. If stripping occurs before 3 days, 100% strength must be achieved. For multistory buildings, enough shoring should be provided for a sufficient number of floors to be built to properly support the construction loading from reshoring.
- C. Formwork supporting the weight of concrete for post-tensioned floor framing may not be removed until all post-tensioning operations have been completed and approved. For multistory buildings, enough shoring should be provided for a sufficient number of floors to be built to properly support the construction loading from reshoring. See General Notes in the drawings for the minimum compressive concrete strength required for stressing of tendons.
- D. Where reshoring is required as part of the formwork removal process, refer to the Shores and Reshores section of this specification.
- E. Determination of early age compressive strength of concrete at time of formwork removal shall be made by compression tests of field-cured cylinders or by the maturity method in accordance with ASTM C1074. If the maturity method is used, submit sufficient data using project materials to demonstrate correlation of measurements on the structure with the compressive strength of laboratory-cured molded cylinders.
- F. Remove formwork progressively using methods to prevent shock loads or unbalanced loads from being imposed on structure. Comply with ACI 347.
- G. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against concrete surfaces.
- H. Whenever formwork is removed during the curing period, the exposed concrete shall be cured per requirements of Section 033000.
- I. All wood formwork, including that used in void spaces, pockets and other similar places shall be removed.

- J. Form tie holes shall be filled as per approved samples submitted to the Design Professionals.
- K. The Contractor shall assume responsibility for all damage due to removal of the forms.

3.4 RE-USING FORMS

- A. Before forms can be re-used, surfaces that will be in contact with freshly poured concrete must be thoroughly cleaned, damaged areas repaired, and projecting nails withdrawn.
 - 1. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable.
 - 2. Apply new form release agent on re-used forms.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joints to avoid offsets.
- C. Forms for exposed concrete may be reused only if the surfaces have not absorbed moisture and have not splintered, warped, discolored, stained, rusted or peeled, subject to acceptance by the Design Professionals. The Design Professionals reserve the right to require the Contractor to remove and reconstruct such formwork as will produce subsequent areas that are acceptable. Do not use "patched" forms for exposed concrete surfaces, unless approved by the Design Professionals.

3.5 CORRECTIVE MEASURES

- A. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in Part 3 – CORRECTIVE MEASURES section of Specification 033000.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCEMENT AND EMBEDDED ASSEMBLIES

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

Provide all labor, materials, equipment, services and transportation for reinforcing steel, accessories, embedments and miscellaneous anchorage accessories, joint fillers, and waterstops for cast-in-place concrete work as shown on Drawings, as specified herein, and as required by the job conditions.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 014500
Concrete Formwork	Section 031000
Cast-In-Place Concrete	Section 033000
Thermal and Moisture Protection	Division 7

1.4 CODES AND STANDARDS

- A. Building Code: Concrete work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.
- B. Standards:
 - 1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 – Specifications for Structural Concrete.
 - 3. ACI 315 – Details and Detailing of Concrete Reinforcement.
 - 4. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.
 - 5. ACI 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
 - 6. ACI 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary
 - 7. American Society for Testing and Materials "ASTM Standards in Building Codes", various standards as referenced herein.
 - 8. AWS D1.1 – Structural Welding Code-Steel.
 - 9. AWS D1.4 – Structural Welding Code-Reinforcing Steel.
 - 10. CRD C 572 – Specification for Polyvinylchloride Waterstops.
 - 11. Concrete Reinforcing Steel Institute "Manual of Standard Practice"

12. ASTM D3963 Fabrication and Jobsite Handling of epoxy Coated Steel Reinforcing Bars.

C. Definitions:

1. See Section 033000.

1.5 CONTRACTOR QUALIFICATIONS

- A. The work of this section shall be performed by a fabricator specializing in the type of reinforcement fabrication required for this Project, with a minimum of 10 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.

1. Welders shall be qualified in accordance with applicable AWS Code within 12 months before starting the work.

- a) Make qualification records available to the Design Professionals upon request.

- B. Manufacturers shall specialize in manufacturing the types of concrete accessories required for cast-in-place concrete work, with a minimum of 10 years of documented successful experience and shall have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty for each type of accessory.

1.6 SUBMITTALS

- A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested. Reproduction of Contract Drawings as shop drawings is not permitted.

- (1) Submittal Schedule
- (2) Shop Drawings
- (3) Product Data
- (4) Mill Reports
- (5) Reinforcement Strain Test
- (6) Hazardous Materials Notification

1. **Submittal Schedule:** See Section 033000.
2. **Shop Drawings:** Submit for action shop drawings that shall clearly indicate, but not be limited to:

- a) All details, dimensions and information required for fabrication and placement of concrete reinforcement in accordance with Contract Documents, prepared in accordance with ACI 315 recommendations.
- b) Elevations, plans, sections, and dimensions of concrete work with required reinforcement clearances.
- c) Ledges, brackets, openings, sleeves, anchor rods, embedments, prefabricated bent-in dowel keyway systems, electrical conduit and items of other trades including interference with reinforcing materials.
- d) Sizes, grade designations, spacing, locations, and quantities of wire fabric, reinforcement bars, temperature and shrinkage reinforcement dowels.

- i. Do not use dimensions scaled from Contract Drawings to determine bar lengths.
 - ii. Hooks and bends not specifically dimensioned shall be detailed per ACI 318.
 - e) Bending and cutting schedules, assembly diagrams, splicing and connection requirements, details, and laps.
 - f) Each type of supporting and spacing devices, including miscellaneous accessories.
 - g) Construction joint type, details, and locations. Contractor shall coordinate construction joint type, details, and locations with concrete pour schedule. Submittal shall include details for each type of construction joint in accordance with Contract Documents.
 - h) Locations and dimensions of openings in structural members including floor slab, shear walls, columns and beams. See SUBMITTALS Section of Specification 033000.
 - i) Concrete accessories and embedded items. See SUBMITTALS Section of Specification 033000.
 3. **Product Data:** Submit for action for each type of product identified in Part 2. Product Data shall be clearly marked to indicate all technical information which specifies full compliance with this section and Contract Documents, including published installation instructions and I.C.C reports, where applicable, for products of each manufacturer specified in this section.
 4. **Mill Reports:** Submit for record.
 5. **Reinforcement Strain Test:** For Grade 75 reinforcement, submit for record certification that steel has a yield strength of no less than 75 ksi as measured by both ASTM A615 and ACI 318 Section 3.5.3.2 procedures.
 6. **Hazardous Materials Notification:** Submit for record. In the event no product or material is available that does not contain hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.
 - B. Submittal Process: See Section 033000.
 - C. SER Submittal Review: See Section 033000.
 - D. Substitution Request: See Section 033000.
 - E. Request for Information (RFI): See Section 033000.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Comply with General Conditions and Division 1, including the following:
 1. Deliver reinforcing steel to Project site bundled, tagged and marked.
 - a) Use weatherproof tags indicating bar sizes, lengths and other information corresponding to markings shown on placement diagrams.
 2. Deliver welded wire fabric in sheets. Do not deliver in rolls.

3. During construction period, properly store reinforcing steel and accessories to assure uniformity throughout the Project.
4. Deliver and store welding electrodes in accordance with AWS D1.4.
5. Immediately remove from site materials not complying with Contract Documents or determined to be damaged.
6. Store reinforcing steel above ground so that it remains clean.
 - a) Maintain steel surfaces free from materials and coatings that might impair bond.
 - b) Keep covered.
 - c) Protect against corrosion or deterioration of any kind.

1.8 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. See Section 014500.

1.9 QUALITY CONTROL BY CONTRACTOR

- A. See Section 033000.

1.10 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

- A. See Section 033000.

1.11 PERMITS AND WARRANTY

- A. Permits: See Section 033000.
- B. Warranty: See Section 033000. Failures include but are not limited to the following:
1. Bars with kinks or bends not indicated on Drawings or on approved shop drawings.
 2. Bars damaged due to bending, straightening or cutting.
 3. Bars heated for bending.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Steel:
1. Type: Deformed billet steel bars, ASTM A 615, Grade 60 or 75 as indicated on Drawings.
 2. Size: As indicated on structural Drawings.
 3. Where indicated on Drawings, reinforcing steel shall be hot-dipped galvanized after fabrication in accordance with ASTM A 767, Class II, with galvanizing material protected from embrittlement during galvanizing process in accordance with ASTM A 143.
 - a) Galvanized finish shall meet the bend and shear test requirements of ASTM A 615.
 4. Epoxy-Coated: ASTM A 775 where indicated on Drawings.
 5. Weldable reinforcement: ASTM A 706 where indicated on Drawings.

B. Welded Wire Reinforcement:

1. Type: steel wire, deformed, ASTM A1064.
2. Size: As indicated on structural Drawings.
3. Where indicated on Drawings, welded wire reinforcement shall be hot-dipped galvanized after fabrication in accordance with ASTM A 1060, , with galvanizing material protected from embrittlement during galvanizing process in accordance with ASTM A 143.
 - a) Galvanized finish shall meet the bend and shear test requirements of ASTM A 615.
4. Plain Steel Welded Wire Reinforcement: ASTM A 1064.
5. Deformed Steel Welded Wire Reinforcement: ASTM A 1064.
6. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884, Class A.

C. Headed Shear Stud Reinforcement At Slab-Column Connections:

1. Type: Stud assemblies consisting of either single-headed studs attached to a structural steel base rail by structural welding or double-headed studs attached to a non-structural steel shape/plate for alignment and for shear reinforcement at slab-column connections shall be in accordance with ASTM A 1044. Headed shear studs per AWS D1.1 are not an acceptable substitution for headed shear stud reinforcement. A
 - a) Shear studs shall be in accordance with either ASTM A108 or ASTM A29, Grade 1010 through 1020. Yield strength shall be 51,000 psi minimum and tensile strength shall be 65,000 psi minimum.
 - b) Rails shall be in accordance with ASTM A36 or CSA 44W. Yield strength shall be 44,000 psi minimum and tensile strength shall be 65,000 psi minimum.
 - c) Studs shall be welded in accordance with AWS D1.1.
 - d) Acceptable Products:
 - i. Studrails by DECON, Inc.
 - ii. DSA by SureBuilt Manufacturing
 - iii. DSR by Dayton Superior Corporation
 - iv. Suncoast SRS by Suncoast Post-Tension, Ltd.
2. Size, quantity and spacing: As indicated on structural Drawings.
3. Installation: Per manufacturer's instructions.
4. Supports: Use plastic molded plastic chairs as provided by the manufacturer to maintain the bottom rebar cover as specified on the Drawings. Tie headed shear stud reinforcement to adjacent top bars to maintain vertical position.

D. Reinforcement Coating Repair Materials:

1. Apply repair coating in accordance with the manufacturer's written procedures.
2. Galvanized Repair Coating: Zinc-based solder, paint containing zinc dust or sprayed zinc complying with ASTM A780.

3. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with D3963/D3963M referencing Annex A2 of ASTM A775/A775M.
 - a) The maximum amount of repaired damaged areas shall not exceed 2% of the surface area in each linear foot of each bar. If more than 2% of the surface area in each linear foot of bar is damaged, bar shall be replaced.

2.2 ACCESSORIES

A. Tie Wire:

1. Type: Minimum 16 gauge (1.5mm) annealed steel wire, ASTM A 510 and ASTM A 853.
2. Wire Bar Type: Comply with CRSI.

B. Mechanical Splicing Systems:

1. Mechanical tension and compression splicing systems shall be used where indicated on Drawings or at contractor's option. For seismic design categories D, E and F, in plastic hinge regions, only Type 2 mechanical splices are permitted.
2. Splices shall be installed in accordance with manufacturer's requirements.
3. Acceptable Products:
 - a) Bartec Couplers by Dextra
 - b) Griptec Couplers by Dextra
 - c) Unitec Couplers by Dextra
 - d) Lenton Couplers by Erico
 - e) Lenton Cadweld by Erico
 - f) Bar Lock Couplers by Dayton Superior
 - g) Taper-Lock Couplers by Dayton Superior
 - h) Grip-Twist by BarSplice
 - i) ZAP Screwlok by BarSplice
 - j) BPI Barsplicer by BarSplice
 - k) BarGrip by BarSplice
 - l) 400 and 500 Series by Headed Reinforcement Corp
4. Mechanical and welded tensile mechanical splicing systems shall be capable of developing 125% of the reinforcing steel ASTM specified minimum yield strength (Type 1) except where indicated as Type 2 (100% of specified tensile strength).
5. Mechanical compression splices shall be such that the compression stress is transmitted by end bearing held in concentric contact.

C. Headed Bars:

1. For bar sizes #11 ($\phi 36$) or smaller where specifically detailed on Drawings, mechanical bar terminators shall be used.
2. Headed bars shall meet the requirements of ASTM A970, Class HA.
3. Acceptable Products:
 - a) Headed Bars by Dextra
 - b) Lenton Terminator by Erico
 - c) Grip-Twist Doughnut by Bar-Splice

- d) BPI ButtonHead by BarSplice
- e) Zap T-Lok by BarSplice
- f) Taper-Lock End Anchor Disc by Dayton Superior
- g) 100, 550 and 670 Series by Headed Reinforcement Corp

D. Weldable Bar Couplers:

1. Acceptable Products:

- a) Lenton Weldable Couplers by Erico
- b) DBDI Weldable Coupler by Dayton Superior
- c) BPI Structural Connector by BarSplice

E. Slip Dowel Bar/Plate Systems for Slab on Grade Joints

1. Acceptable Products:

- a) Speed Dowel or Speed Plate by Sika Corporation
- b) QuicDowel or QuicPlate by BoMetals, Inc.
- c) Diamond Dowel System by PNA Construction Technologies

F. Supports for Reinforcement:

- 1. Types: Bolsters, chairs, spacers, clips, chair bars, and other devices for properly placing, spacing, supporting, and fastening the reinforcement, plastic, plastic protected steel, or epoxy coated to match supported reinforcement.
- 2. For Contact with Forms: Use types with not less than 3/32" (2.5mm) of plastic between metal and concrete surface.
 - a) Plastic tips shall extend not less than 1/2" (12mm) on metal legs.
- 3. Individual and continuous slab bolsters and chairs shall be of type to suit various conditions encountered and must be capable of supporting 300 pound (1.5kN) load without damage or permanent distortion.
- 4. Unless otherwise indicated on Drawings, bottom reinforcing bars in footings shall be supported by precast concrete bricks or individual high chairs with welded sand plates on bottom.
- 5. For Slabs on Grade: Use supports with sand plates or horizontal runners where base material will not support chair legs.

G. Deformed Bar Anchors:

- 1. Type: Automatic end welded, ASTM A 496 quality.
- 2. Size and Grade: As indicated on structural Drawings by Nelson Stud Welding.

H. Anchor rods and dowels:

- 1. Types and Sizes: Provide sizes and types of anchor rods and dowels as indicated on the Drawings. Each type of anchor shall be manufactured of structural quality steel, designed for cast-in-place concrete applications and be of sizes as indicated on Drawings, complete with washers, nuts, plates and miscellaneous accessories required to meet Contract Document requirements.

2. Adhesive Anchors for anchor rods and dowels in existing concrete: See Anchorage Accessories.
- I. Prefabricated Bent-In Dowel Keyway Systems and Dowel Bar Replacements:
1. Type, Size and Grade as indicated on Drawings.
 2. Dowels shall be installed in accordance with manufacturer's requirements
 3. Acceptable Products:
 - a) Lenton Form Savers by Erico
 - b) Keyway Splice Box by Meadow Burke
 - c) Metalstrip by Dayton Superior
 - d) DBDI Splice System by Dayton Superior
 - e) D50 DBR Coupler System by Dayton Superior
 - f) BPI Barsplicer by BarSplice
 - g) 300 Series by Headed Reinforcement Corp

2.3 ANCHORAGE ACCESSORIES

- A. General: Miscellaneous anchorage accessories for anchoring structural, architectural, electrical, and mechanical items to poured concrete shall include but not be limited to the following:
1. Concrete Anchors: Headed or bent studs ASTM A 108/Grade 1015 through 1020, minimum yield strength of 50,000 psi (345MPa), minimum tensile strength of 60,000 psi (415MPa).
 2. Anchor Rods: ASTM F1554, Grade as noted on Drawings.
 3. Shallow Embedment Internally Threaded Inserts with 3/4" maximum embedment.
 - a) Acceptable Products:
 - i. Mini Undercut + by DeWalt (for post-tensioned slabs and precast hollow core slabs)
 - ii. HDI-P TZ by Hilti (for post-tensioned slabs)
 4. Adhesive Anchors:
 - a) Basis of Design: See General Notes
 - b) Substitution Request: As anchor capacities vary by manufacturer, the following anchors will be considered as a Substitution Request. Refer to project specifications for Substitution Request procedure
 - i. HIT-RE 500-V3 by Hilti, Inc.
 - ii. Epcon C6+ by ITW Red Head
 - iii. Epcon G5 by ITW Red Head
 - iv. Pure 110+ by DeWalt
 - v. SET-3G by Simpson Strong-Tie Co.
 - c) The adhesive anchor system used for post-installed anchorage to concrete shall conform to the requirements of ACI 355.4 and commentary and shall possess a current ICC-ES report demonstrating compliance with ACI 318.

5. Expansion Anchors:
 - a) Basis of Design: See General Notes
 - b) Substitution Request: As anchor capacities vary by manufacturer, the following anchors will be considered as a Substitution Request. Refer to project specifications for Substitution Request procedure.
 - i. Kwik Bolt 1 (KB1) by Hilti, Inc.
 - ii. Power Stud+ SD1 or SD2 by DeWalt
 - iii. Power Stud + SD6 (SS) by DeWalt
 - iv. Trubolt by ITW CCNA
 - v. Strong-Bolt 2 by Simpson Strong-Tie Co.
 - c) The expansion anchors used for post-installed anchorage to concrete shall conform to the requirements of ACI 355.2 and commentary and shall possess a current ICC- ES or IAPMO UES report demonstrating compliance with ACI 318.
6. Threaded Screw Anchors:
 - a) Basis of Design: See General Notes
 - b) Substitution Request: As anchor capacities vary by manufacturer, the following anchors will be considered as a Substitution Request. Refer to project specifications for Substitution Request procedure.
 - i. Screw-Bolt + by DeWalt
 - ii. Tapcon + by ITW Red Head
 - iii. Titan HD by Simpson Strong-Tie Co., Pleasanton, CA
7. Inserts and Coil Rods: Yield strength 65,000 psi (450MPa), ASTM B 633, manufactured by Acrow-Richmond Limited or Dayton Superior
8. Welding Electrodes: AWS 5.5, Series E70.
9. Welded Deformed Bar Anchors: Welded by full-fusion process, as furnished by TRW Nelson Stud Welding Division or equivalent.

B. Dovetail Anchor Slots:

1. Type: Formed 22 gauge (0.85mm) galvanized steel
2. Acceptable Manufacturers:
 - a) Heckmann Building Products
 - b) Hohmann and Barnard,
 - c) BoMetals, Inc..
3. Location of Use: Continuous installation of anchor slots, full height of masonry walls, where masonry walls abut poured concrete walls.
4. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.
5. Finish: Hot-dip galvanized or zinc-plated steel.
6. Stainless steel anchors are acceptable.

2.4 JOINT FILLERS

- A. Permanent Compressible Joint Filler:
1. Acceptable Product: W. R. Meadows: “Ceramar” closed-cell expansion joint filler, ultraviolet stable, minimal moisture absorption, non-impregnated, nonstaining and nonbleeding, inert and compatible with cold-applied sealants.
 2. Location of Use: Slabs and curbs as indicated on Drawings or required.
 3. Thickness: As indicated on Drawings or required.
- B. Temporary Compressible Joint Filler:
1. Type: White molded polystyrene beadboard.
 2. Location of Use:
 - a) In slabs, curbs, and walls which must be removed prior to joint sealant installation.
 - b) Vertically to isolate walls from columns or other walls.
- C. Semi Rigid Joint Filler:
1. Acceptable Product: Euclid Chemical Company “Euco 700” or “Euco QWIKjoint 200”
 2. Acceptable Product: Sika Corporation “Sikadur 51 SL”
 3. Acceptable Product: W.R. Meadows Sealtight “Rezi-Weld Flex”
 4. Acceptable Product: SpecChem “SpecPoxy CJ” or “Rapid Flex 90”
- D. Noncompressible Joint Filler:
1. Acceptable Product: Dow Chemical's "STYROFOAM 40" rigid closed-cell extruded polystyrene board, square edges, 40 psi (275kPa) compressive strength, ASTM C 578, Type IV.
 2. Thickness: As indicated on Drawings.
 3. Location of Use: As indicated on Drawings or required.
- E. Asphalt-Impregnated Joint Filler:
1. Acceptable Product: W.R. Meadows Asphalt Expansion Joint Filler, preformed, ASTM D 994.
 2. Thickness: 1/2” (12mm) maximum, as indicated on Drawings or required.
 3. Location of Use: Sidewalks at foundation walls and as indicated on Drawings or required.
- F. Asphalt-impregnated fiberboard expansion joint filler for interior work:
1. Type: ASTM D1751.
- G. Self-expanding cork board expansion joint filler for exterior work:
1. Type: ASTM D1752.
- H. Construction Joints:

1. Type: Tongue and groove type profile of galvanized steel, with knock-out holes at 6" (150mm) on center to receive dowelling, complete with anchorage.

2.5 WATERSTOPS

- A. Preformed Swellable Waterproofing Strips especially formulated for concrete cold joints at footings, walls, or slabs.
 1. Acceptable Products:
 - a) Volclay Waterstop RX by CETCO Building Materials Group
 - b) Adcor ES by GCP Applied Technologies
 - c) Hydrotite by Sika
 2. Size: 3/4" (20mm) by 3/8" (10mm) strips minimum, 25 ft. (7.5m) long, and weighing at least 0.165 lbs/ft (0.245kg/m).
 3. Location of Use: Concrete cold joints at footings, walls and slab joints.
 4. Comply with manufacturer product application and installation instructions.
- B. Polyvinyl Chloride Waterstops:
 1. Type: PVC Waterstops for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections and directional changes. U.S. Corp of Engineers Specification CRD C 572.
 2. Acceptable Products:
 - a) PVC Waterstops" by BoMetals
 - b) Greenstreak by Sika
 - c) Sealtight PVC Waterstops by W.R. Meadows

PART 3 - EXECUTION

3.1 FABRICATION

- A. Reinforcing Steel Fabrication:
 1. Fabricate in accordance with approved shop Drawings, ACI 315 and Contract Documents.
 2. Heating of Reinforcement: Will be permitted only with specific prior approval of the SER.
 3. Welding: Comply with ANSI/AWS D1.4; use E9018 electrodes or approved electrodes.
 4. Tolerances: Comply with ACI 117.
 5. Unacceptable Materials: Reinforcement with any of following defects will not be permitted in Work.
 - a) Bar lengths, depths, and bends exceeding ACI fabrication tolerances.
 - b) Bends or kinks not indicated on Drawings or final shop drawings.
 - c) Bars with reduced cross-section due to excessive rusting or other cause.
- B. Welded Wire Reinforcement:

1. Type: As fabricated in accordance with CRSI, unless otherwise noted.
- C. Templates:
1. Required for all footing and column dowels, and where required for proper alignment of reinforcing.
- D. Assemblies:
1. Fabricate and assemble structural steel items in shop in conformance with AISC and AWS D1.1. Shearing, flame cutting, and chipping shall be done carefully and accurately. Cut, drill, or punch holes at right angles to the surface of the metal. Do not make or enlarge holes by burning. Holes shall be clean-cut without torn or ragged edges.
 2. Welding of deformed bar anchors and headed stud anchors shall be installed by full-fusion process equivalent to TRW Nelson Stud Welding Division or KSM Welding Services Division, Omark Industries or Tru-Weld Stud Welding, Medina, OH.
 3. Welding of reinforcement shall be done in accordance with AWS requirements. Welding shall be performed subject to the observance and testing by Testing Agency.
 4. Galvanizing where required, shall be applied after fabrication and prior to casting concrete.
 5. Welding of crossing bars (tack welding) for assembly of reinforcement is not permitted without use of weldable reinforcement and express written consent of SER.

3.2 INSTALLATION OF REINFORCEMENT

- A. General:
1. Perform the work of this section in accordance with approved shop drawings, ACI 318 and CRSI recommended practice for “Placing Reinforcing Bars”, for details and methods of reinforcement placement and supports, and as specified.
 2. Before placing reinforcement steel, inspect forms for proper fitting and compliance with allowable tolerances.
 3. Reinforcement shall be free of form coatings, sealers, powdered and scaled rust, loose mill scale, earth, ice, and other materials which will reduce or destroy bond with concrete.
 4. Do not place concrete until the completed reinforcement steel work has been observed and accepted by Owner’s Testing Laboratory.
 5. Reinforcement steel is not permitted to be “floated into position”.
 6. Bend bars cold.
 - a) Do not heat or flame cut bars.
 - b) No field bending of bars partially embedded in concrete is permitted, unless specifically approved by the SER and tested by Testing Agency for cracks.
 7. Weld only as indicated.
 - a) Perform welding per ANSI/AWS D12.1 and/or ANSI/AWS D1.4.
 - b) See structural Drawings for additional requirements.
 8. Tag reinforcement steel for easy identification.

B. Placement of Reinforcement Bars:

1. Comply with approved shop drawings, ACI 318 and Contract Documents.
2. Accurately position, support and secure reinforcement in a manner to prevent displacement before and during placement of concrete.
 - a) Place reinforcement bars within tolerances specified in ACI 117.
 - b) Locate and support reinforcement by metal chairs, runners, bolsters, spacers, hangers and other accessories for fastening reinforcing bars and welded wire reinforcement in place.
3. If bars are displaced beyond specified tolerance when relocating the bars to avoid interference with other reinforcement or embedded items, immediately notify the Design Professionals for approval prior to concrete placement.
4. Avoid cutting or puncturing vapor retarder during reinforcement placement.
 - a) Repair damages before placing concrete.
5. Concrete Coverage: Maintain concrete cover around reinforcement as indicated on Drawings.
6. Bar Supports: Use type specified in this section.
7. Tie Wires: After cutting, turn tie wires to the inside of section and bend so that concrete placement will not force ends to be exposed at face of concrete.

C. Placement of Wire Reinforcement:

1. Install in lengths as long as practicable.
2. Support in position adequately to prevent bending of reinforcement between supports before and during placement of concrete.
3. Overlap the wire reinforcement 6" (150mm) or one panel width + 2" (50mm), whichever is larger.
 - a) Securely tie together with wire.
4. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Locate wire fabric in the top third of slabs, unless noted otherwise on structural Drawings.

D. At Construction Joints:

1. Reinforcement bars and wire reinforcement shall be continuous through construction joints, unless otherwise indicated on Drawings. See Drawings for scheduled lap splices.

E. At Expansion Joints:

1. Reinforcing bars and wire fabric shall NOT be continuous through expansion joints, unless otherwise indicated on Drawings.

F. Splicing:

1. Unless otherwise indicated on Drawings provide lap splices for bar sizes #11 (ø36) and smaller by lapping ends, placing bars in contact, and tying tightly with wire in accordance with requirements of ACI 318 for lap lengths indicated on Drawings.
2. At all #14 (ø43) and #18 (ø57) bars and where mechanical splices are specifically indicated on Drawings, comply with requirements specified in this Specification section under “Mechanical Splicing Systems”.
3. Do not splice reinforcement except as indicated on structural Drawings.
4. Tension couplers may be used and installed per manufacturer’s specifications where indicated on Drawings or as approved by Engineer.

G. Dowels in Existing Concrete:

1. Install dowels and dowel adhesive in accordance with manufacturer’s recommendations.
2. Minimum embedment length shall be 12 bar diameters, unless noted otherwise.

3.3 INSTALLATION OF POST-INSTALLED ADHESIVE ANCHORS

A. General:

1. Post-installed adhesive anchors shall be installed in accordance with the Manufacturer’s Printed Installation Instructions (MPII).
2. The adhesive anchors shall be supplied as an entire system. The contractor shall provide all equipment required to install the adhesive anchor in accordance with the MPII.
3. Anchors shall be installed in holes drilled with a rotary impact hammer drill with carbide bit. Contractor shall obtain prior written approval from SER before using rock drilling or core drilling installation methods.
4. Anchor holes shall be thoroughly cleaned and dry prior to adhesive injection, in accordance with the MPII. Anchors to be installed in the adhesive shall be clean, oil-free, and free of loose rust, paint, or other coatings.
5. Concrete shall have a minimum compressive strength of 2500 psi (17MPa).
6. Concrete at time of adhesive anchor installation shall have a minimum age of 21 days.
7. Concrete temperature at the time of adhesive anchor installation shall be at least equal to manufacture's requirements, or 50° F (10°C) if no requirement exists.
8. Support the anchor and protect it from disturbance or loading for the full cure time stated by the manufacturer at that base material temperature.
9. Unless specified otherwise in the contract documents, anchors shall be installed perpendicular to the concrete surface. Anchors displaced or disturbed prior to the adhesive cure time shall be considered damaged and reported to the SER (see Observations and Corrections section of 033000).
10. Locate, by non-destructive means, and avoid all existing reinforcement prior to installation of anchors. If existing reinforcement layout prohibits the installation of anchors as indicated in the drawings the contractor shall immediately notify the Design Professionals.
11. Reinforcement bars or all-threaded bars shall not be bent after being adhesively embedded in hardened, sound concrete, unless written approval is given by the SER.
12. All personnel installing anchors shall be trained by the manufacturer on proper installation techniques. Submit for record certificate from training documentation from the manufacturer for each installer on this Project

13. Installation of adhesive anchors horizontally or upwardly inclined and anchors that are designated with a (CERT) after the anchor call-out, shall be performed by personnel certified by the ACI/CRSI Adhesive Anchor Installer Certification program. Submit for record certificate from ACI-CRSI Adhesive Anchor Installation Certification Program for each certified installer on this Project.

3.4 INSTALLATION OF ACCESSORIES AND EMBEDDED ITEMS

- A. Install concrete accessories in accordance with manufacturer's published instructions and Contract Documents.
 1. Set and secure embedments, including embedded plates, bearing plates, and anchor rods, per approved setting drawings and in such a manner to prevent movement during placement of concrete and to allow removal of formwork without damage.
 2. Tolerances: Anchor rod and other embedded items placement tolerances shall comply with AISC 303, "Code of Standard Practice", Section 7.5.
 3. Inspect locations to receive concrete accessories.
 4. Immediately notify the Design Professionals in writing of conditions that will adversely affect the Work or fail to meet Contract Document requirements.
 5. Do not place concrete until reinforcement, accessories and other built-in items have been inspected and accepted by Testing Agency.
- B. Construction and Contraction (Control) Joints:
 1. Construction and contraction (control) joints indicated on Drawings are mandatory and must not be omitted.
 - a) Provide construction joints in accordance with ACI 318.
 - b) Roughen surface at construction joints as indicated on the drawings.
 - c) Where specifically indicated on drawings, provide 1-1/2" (40mm) deep key type construction joints at end of each placement for slabs, beams, walls and footings.
 - i. Bevel forms for easy removal.
 2. Provide waterstops in construction joints as indicated on the Contract Documents in sizes to suit joint.
 3. Install waterstops to form continuous diaphragm in each joint.
 4. Support and protect exposed waterstops during progress of Work.
 5. Field-fabricate joints in waterstops according to manufacturer's printed instructions.
- C. Coordinate the installation of pipes, bolts, hangers, anchors, flashing and other embedded items with the work of other trades.

3.5 CORRECTIVE MEASURES

- A. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in Part 3 – CORRECTIVE MEASURES section of Specification 033000.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

Provide all labor, materials, equipment, services and transportation required to complete all concrete work as shown on Drawings, as specified herein, and as required by the job conditions. This Specification is not intended to address the particular requirements of Architectural Concrete.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 014500
Concrete Formwork	Section 031000
Concrete Reinforcement and Embedded Assemblies	Section 032000
Thermal and Moisture Protection	Division 7

1.4 CODES AND STANDARDS

- A. Building Code: Concrete work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.
- B. Standards:
1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials except as modified by more stringent requirements in the Project Specifications and/or Drawings.
 2. ACI 237 – Self Consolidating Concrete.
 3. ACI 301 – Specifications for Structural Concrete.
 4. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.
 5. American Concrete Institute “Manual of Concrete Practice”, various committee reports as referenced herein.
 6. American Society for Testing and Materials "ASTM Standards in Building Codes", various standards as referenced herein.
 7. AASHTO T318 – Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
- C. Definitions:
1. The term “Contract Documents” in this Specification is defined as the design Drawings and the specifications.

2. The term “SER” in this Specification is defined as the Structural Engineer of Record for the structure in its final condition.
3. The term “Design Professionals” in this Specification is defined as the Owner’s Architect and SER.
4. The term “Contractor” in this Specification is defined to include any of the following: General Contractor and their sub-contractors, Construction Manager, Concrete Contractor and their sub-contractors.
5. The term “Testing Agency” in this Specification is defined as an independent testing and inspection service engaged by the Owner for quality assurance testing and inspection of structural construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.
6. The terms “for record” and “submit for record” in this Specification are defined as Contractor submittals that do not require a response from the Design Professionals.
7. The term “Working Days” in this Specification is defined as Monday through Friday, excluding federal or state holidays.
8. The term “Delegated Design” in this Specification is defined as a scope of work that meets performance and design criteria established in the Contract Documents and is to be completed by the Contractor’s licensed engineer.

1.5 CONTRACTOR QUALIFICATIONS

- A. The work of this section shall be performed by a company specializing in the type of concrete work required for this Project, with a minimum of 10 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.
- B. Contractor’s testing agency services: Required as specified in Division 1, and herein.

1.6 SUBMITTALS

- A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested. Reproduction of Contract Drawings for shop drawings is not permitted. Building Information Models for contractor’s use may be provided as mutually agreed upon by Design Professionals.

- (1) Submittal Schedule
- (2) Mix Designs
- (3) Concrete Travel Times to the Project Site
- (4) Hot and Cold Weather Procedures
- (5) Product Data
- (6) Concrete Joint Locations
- (7) Comprehensive Layout Drawings
- (8) Preconstruction Survey
- (9) Survey of Flat Plate or Flat Slab Concrete Floors during construction
- (10) FF/FL Testing
- (11) Structural Repairs
- (12) Patching Defective Concrete Finishes
- (13) Conduit and Pipes Embedded in Concrete
- (14) Hazardous Materials Notification

1. **Submittal Schedule:** The contractor shall submit for action a schedule at least twenty (20) working days prior to commencing submittals.
 - a) This schedule shall include a list, in order of date to be submitted, of all drawings and other required submittal items scheduled to be submitted. The schedule shall list the proposed submittals for each week, as well as their formats. Once shop drawing submissions have commenced any modification or addition to this schedule must be submitted for action at least twenty (20) working days before the modification or addition is proposed to take place.
 - b) If at any time the total number of shop drawings received in any one week period exceeds the amount in the approved schedule by more than 10% for that week, the Design Professionals have the right to add two days to the average turnaround time for each 20% increment in excess of the scheduled quantity for that week's submissions. For example if the weekly total exceeds the schedule by 10% to 20%, two days may be added; if it is exceeded by 21% to 40%, four days may be added. The return dates for subsequent submittals may be extended based on the additional review time stated above.
 - c) For the purposes of developing a schedule, assume the following review rate, Shop drawings – 10 full size sheets per week.

2. **Mix Designs:** Submit for action concrete mix designs for each type and strength of concrete required for this Project at least thirty (30) days before placing concrete.
 - a) Mix designs shall be prepared or reviewed by an approved independent testing agency retained by the Contractor in accordance with requirements of ACI 301 and ACI 318 and shall be coordinated with design requirements and Contract Documents.
 - b) Before submitting to Testing Agency, submit complete mix design data for each separate mix to be used on the Project in a single submittal.
 - c) Provide a completed "Concrete Mix Design Submittal Form" (attached to the end of this Specification Section) for each proposed concrete mix.
 - d) Mix materials shall be from the same production facility that will be used for this Project.
 - e) Mix Design data shall include but not be limited to the following:
 - i. Locations on the Project where each mix design is to be used corresponding to Structural General Notes on the Drawings.
 - ii. Design Compressive Strength: As indicated on the Drawings.
 - iii. Proportions: ACI 301 and ACI 318.
 - iv. Gradation and quality of each type of ingredient including fresh (wet) unit weight, aggregates sieve analysis.
 - v. Water/cementitious material ratio.
 - vi. Evaluation and classification fly ash in accordance with ASTM D 5759.
 - vii. Report of chemical analysis of fly ash in accordance with ASTM C 618.
 - viii. Classification of slag cement in accordance with ASTM C 989.
 - ix. Slump: ASTM C 143.

- x. Certification and test results of the total water soluble chloride ion content of the design mix - AASHTO T260 or ASTM C 1218 at age between 28 and 42 days.
 - xi. Air content of freshly mixed concrete by the pressure method, ASTM C 231, or the volumetric method, ASTM C 173.
 - xii. Density of Concrete: ASTM C 138.
 - xiii. Design strength at 28, 56 or 90 days, as indicated on Contract Documents: ASTM C 39.
 - (1) Document strength based on basis of previous field experience or trial mixtures per ACI 301. Proportioning by water-cement ratio alone, with no test results per the trial mixtures procedure is not permitted.
 - (2) Submit strength test records, mix design materials, conditions, and proportions for concrete used for record of tests, standard deviation calculation, and determination of required average compressive strength. Test records to support proposed mixtures shall be no more than 24 months old and use current cement aggregate sources. Test records to establish standard deviation may be older if necessary to have the required number of samples.
 - (3) If early concrete strengths are required, Contractor shall submit trial mixture results as required.
 - xiv. Manufacturer's product data for each type of admixture.
 - xv. Manufacturer's certification that all admixtures used are compatible with each other.
 - xvi. All information indicating compliance with Contract Documents including method of placement and method of curing.
 - xvii. Normalweight Concrete: Density per ASTM C 138. Design the mix to produce the strength, modulus of elasticity and density as indicated on the Contract Documents.
 - xviii. Lightweight Concrete: Density per ASTM C 138. Design the mix to produce the strength, modulus of elasticity and density as indicated on the Contract Documents.
 - (1) Where lightweight concrete members are used, provide split cylinder strength factor, f_{ct} , as indicated.
 - xix. Certification from a qualified testing agency indicating absence of potential for deleterious expansion of concrete due to alkali reactivity of the aggregate as determined by testing per ASTM C1260 in accordance with ASTM C 33. If potential for deleterious expansion exists, expansion reduction and mitigation measures per the guidelines of ASTM C1778 or US Army COE CRD-C662 shall be submitted for review by the SER.
3. **Concrete Travel Times to the Project Site:** Submit for record.
4. **Hot and Cold Weather Procedures:** Submit for record written procedures for placement of concrete in hot and cold weather conditions. Hot and Cold weather are as defined in the Concrete Placement section of this Specification.

5. **Product Data:** Submit for action product data clearly marked to indicate locations to be used and all technical information which specifies full compliance with this section and Contract Documents, including published application instructions, product characteristics, compatibility, and limitations for each of the following:
 - a) Bonding agents.
 - b) Curing compound and liquid sealer densifier. Submit for record to Design Professionals a written statement guaranteeing that the compound will not leave discoloration on concrete to be left exposed, or affect the bond for paint or other applied finishes. Include provision in written statement that in the event of failure of applied finishes to bond to membrane cured concrete, to remove the curing compound and leave suitable surfaces for bonding such finishes.
 - c) Absorptive covers and moisture retaining covers.
 - d) Vapor Retarder: See Division 7, Thermal and Moisture Protection.
 - e) Self-leveling concrete topping.
 - f) Grout: Submittal of grout by manufacturers not listed herein must be accompanied by independent certification of ASTM C 1107 compliance without modification of standard methods.
 - g) Other products proposed by Contractor.

6. **Concrete Joint Locations:** Submit for action plans indicating locations and details of construction joints, contraction joints, waterstops, sleeves, embedments, etc. that interact with the joints. Contractor to coordinate joint location with reinforcement shop drawings. Reinforcement shop drawings shall indicate additional reinforcement bars where required at construction joints.

Joint locations for concrete slabs to receive a terrazzo or similar finish subject to reflective cracking must be coordinated with layout of finish drawings.

7. **Comprehensive Layout Drawings:** Submit for action comprehensive layout drawings (a single drawing per area/element):
 - a) Drawings shall show openings in structural members, including floor slab, shear walls, columns and beams.
 - b) Drawings shall consolidate the work of all trades and shall be coordinated by the Contractor.
 - c) Drawings shall show concrete accessories and embedded items, including fabrication details of items to be placed (exclusive of reinforcement).
 - d) Submit with or prior to reinforcement and formwork submittals for same element/area.

8. **Preconstruction Survey:** Submit for record. Where interface with existing construction occurs, before related shop drawings are prepared survey the existing construction and submit the survey prepared by a professional surveyor employed by the Contractor to the Design Professionals.
9. **Survey of Flat Plate or Flat Slab Concrete Floors during construction:** Submit for record. Survey requirements are described on Drawings. Based on survey results, SER may propose adjustments to formwork and camber.
10. **FF/FL Testing:** Submit for record. Testing Agency to test and report flatness (F_F), levelness (F_L) prior to shoring removal. Do not test slabs for levelness (F_L)

that include camber, inclined surfaces or planned changes in floor surface slope. Perform F_F/F_L testing in accordance with ASTM E 1155 requirements.

11. **Structural Repairs:** Submit for action procedures, intended locations, and product information. Alterations to design shall be sealed and signed by a Professional Engineer licensed in the state where the project is located.
12. **Patching Defective Concrete Finishes:** Submit for action procedures, intended locations, and product information.
13. **Conduit and Pipes Embedded in Concrete:** Submit for action layout of embedded conduit and pipes.
14. **Hazardous Materials Notification:** Submit for record. In the event no product or material is available that does not contain hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. Submittal Process

1. Submittal of shop drawings and other submittals by the Contractor shall constitute Contractor's representation that the Contractor has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each drawing with other Drawings and other trades. The Contractor shall place their shop drawing stamp on all submittals confirming the above.
2. Shop drawings: Submit in complete packages so that individual parts and the assembled unit may be reviewed together. This Specification Section and the applicable Drawings used in the development of the shop drawings shall be referenced on each shop drawing to facilitate checking.
3. The Contractor shall submit to the Design Professionals one (1) electronic copy for shop drawing review. The naming convention of each drawing must follow the submittal numbering system and include the submittal number, Specification number, revision number and drawing number in the prefix of the drawing name.
4. The Contractor shall allow at least ten (10) working days between receipt and release by the SER for the review of shop drawings and submittals.
5. All modifications or revisions to submittals and shop drawings must be clouded, with an appropriate revision number clearly indicated. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Design Professionals:
 - a) Failure to specifically cloud modifications
 - b) Unapproved revisions to previous submittals
 - c) Unapproved departure from Contract Documents
6. Resubmittals: Completely address previous comments prior to resubmitting a drawing. Resubmit only those drawings that require resubmittal. Do not include new content not previously reviewed.
7. Resubmittals Compensation: The Contractor shall compensate the Design Professionals for submittals that must be reviewed more than twice due to Contractors' errors. The Contractor shall compensate the Design Professionals at standard billing rates plus out-of-pocket expenses incurred at cost + 10%.
8. The Contractor shall deliver to the Design Professionals at the completion of the job two (2) copies of the electronic version of the final as-built shop drawings on a CD-ROM or other media acceptable to the Design Professionals.

C. SER Submittal Review

1. The Design Professionals' review and approval of shop drawings and other submittals shall be for general conformance with the design intent of the work and with the information given in the Contract Documents only and will not in any way relieve the Contractor or the Contractor's Engineer from:
 - a) Conforming to the Contract Documents.
 - b) Coordination with other trades.
 - c) Responsibility for all required detailing and proper fitting of construction work.
 - d) The necessity of furnishing material and workmanship required by Drawings and Specifications which may not be indicated on the shop drawings.
 - e) Control or charge of construction means, methods, techniques, sequences or procedures, for safety precautions and programs in connection with the work.

2. TYPE 1 – Structural Submittal Review Stamp: For shop drawings for building elements designed by the SER, the responses on the shop drawing review stamp used by the SER require one of the following actions:
 - a) APPROVED indicates that the SER has found that the information presented on the shop or erection drawing appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.
 - b) APPROVED AS NOTED indicates that the SER requires the shop or erection drawing to be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected shop or erection drawing for record.
 - c) REVISE and RESUBMIT indicates that the SER requires resubmission of the shop or erection drawing after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.
 - d) NOT APPROVED indicates that the shop or erection drawing does not conform to the Contract Documents and must be extensively revised before re-submittal. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

3. TYPE 2 – Delegated Design Review Stamp: For submittals for building elements which are not designed by the SER but are delegated design items, or for items that do not form part of the completed structural system but impose loads on the structure, or for construction items or activities which have an effect on the final structure. The responses on the stamp used by the SER require one of the following actions:

- a) NO EXCEPTIONS indicates that the SER has found that the information presented on the submittal appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.
- b) EXCEPTIONS NOTED indicates that the SER requires the submittal be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected document for record.
- c) REJECTED indicates that the SER requires resubmission of the submittal after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed. Contractor to revise and resubmit until SER response of No Exceptions or Exceptions Noted is received.

D. Substitution Request

1. Requests for any departure from Contract Documents must be submitted in writing by the Contractor and accepted in writing by the Design Professionals, prior to receipt of submittals.
2. All substitutions must be requested using the structural substitution request form included at the end of this section. Acceptance using the structural substitution request form indicates acceptability of the structural concept only. Contractor must submit shop drawings reflecting accepted substitutions for review in accordance with this Specification. The structural substitution request form, even if accepted, does not constitute a change order.
3. Accepted substitutions or modifications shall be coordinated and incorporated in the work at the sole expense of the Contractor.
4. The acceptance by the Design Professionals of a specific and isolated request by the Contractor to deviate from these requirements does not constitute a waiving of that requirement for other elements of, or locations in the project, unless specifically addressed as such and permitted by the Design Professionals in writing.
5. Compensation for Additional Services: Should additional work by Design Professionals such as design, documentation, meetings and/or site visits be required which are necessitated for the review and/or incorporation of the Contractor-requested substitution, including indirect effects on other portions of the work, the Contractor is responsible for paying for additional work performed by the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.
6. Contractor is responsible for means and methods and any impacts on other portions of the work that may arise from this substitution.

E. Request for Information (RFI)

1. RFIs shall be submitted by the Contractor. RFIs submitted by other entities will be returned with no response.
2. Limit RFI to one subject.
3. Submit RFI immediately upon discovery of the need for interpretation or clarification of the Contract Documents. Submit RFI within timeframe so as not to

delay the Construction Schedule while allowing the full response time described below.

4. The response time for answering an RFI depends on the category in which it is assigned.
 - a) Upon receipt by the SER, each RFI will be assigned to one of the following categories:
 - i. No cost clarification
 - ii. Shown in Contract Documents
 - iii. Change to be issued in future document revision
 - iv. Previously answered
 - v. Information needs to be provided by others
 - vi. Request for corrective field work
 - vii. Request for substitution
 - b) RFIs in the first five categories listed above will be turned around by the SER on average of five (5) working days.
 - c) RFIs in the last two categories listed above will be immediately rejected and must be submitted as submittals or requests for substitution.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with General Conditions and Division 1.
- B. Storage:
 1. Store materials in accordance with ACI 304R.
 2. Store cement in weather-tight buildings, bins or silos that will exclude moisture and contaminates.
 3. Store admixtures to avoid contamination, evaporation, damage, and in accordance with manufacturer's temperature and other recommendations.
 4. Keep packaged material in original containers with seals unbroken and labels intact until time of use.
- C. Handling:
 1. Handle fine and coarse aggregates as separate ingredients.
 2. Arrange aggregate stockpiles to avoid excessive segregation, and prevent contamination with other materials or with other sizes of like aggregates.
 3. Do not use frozen or partially frozen aggregates.
 4. Allow sand to drain until it has reached relatively uniform moisture content before use.
 5. Protect liquid admixtures from freezing and temperature changes that would adversely affect characteristics, and in accordance with manufacturer's recommendations.

1.8 PRE-CONCRETE CONFERENCE

- A. At least 30 working days prior to the start of concrete construction, the Contractor shall hold a meeting to review the proposed concrete mix designs and to determine the procedures for producing proper concrete construction. The Contractor shall notify the Design Professionals of the meeting and require responsible representatives of every party

who is concerned with the concrete Work to attend the conference, including but not limited to the following:

1. Contractor's superintendent.
 2. Testing Agency representative responsible for field quality control.
 3. Concrete subcontractor.
 4. Ready-mix concrete producer.
 5. Admixture manufacturer(s).
 6. Architect.
 7. Structural Engineer.
- B. Minutes of the meeting shall be recorded and distributed by the Contractor to all parties concerned within five working days of the meeting. One copy of the minutes shall also be furnished to the following:
1. Design Professionals.
 2. Owner's Representative.
- C. The minutes shall include a statement by the concrete contractor and admixture manufacturer(s) indicating that the proposed mix design and placing, finishing, and curing techniques can produce the concrete properties and quality required by these Specifications.

1.9 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. See Section 014500.

1.10 QUALITY CONTROL BY CONTRACTOR

- A. The Contractor shall provide a program of quality control to ensure that the minimum standards specified herein are attained.
- B. The Owner's general review during construction and activities of the Testing Agency are undertaken to inform the Owner of performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.
- C. The Contractor shall immediately notify the Design Professionals of any deficiencies in the work which are departures from the Contract Documents. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Design Professionals and Owner, the Contractor shall correct the deficiency at no cost to the Owner. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in the OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS section of this Specification.
- D. Where SCC is used, the Ready Mix Producer shall have a Quality Control Representative on site during placements until mix consistency and stability is established.

1.11 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

- A. Observations: The Design Professionals will observe the construction for general compliance with the provisions of the Contract Documents during various phases of construction.
- B. Corrections by Design Professionals: See Part 3 - CORRECTIVE MEASURES section of this Specification.

1.12 PERMITS AND WARRANTY

- A. Permits: The Contractor shall apply for, procure, renew, maintain, and pay for all permits required by City, State, or other governing authorities, necessary to execute work under this Contract. Contractor shall furnish copies of all permits to the Owner and Design Professionals.
- B. Warranty: Comply with General Conditions, agreeing to repair or replace specified materials or work that has failed within the warranty period. Failures include but are not limited to the following:
 - 1. Oily, waxy or loose residue which may interfere with the bonding or discoloration of various applied Architectural finish materials.
 - 2. Discoloration of concrete surfaces scheduled to remain exposed as a finish.
 - 3. Areas which show surface failure or defects.
 - 4. Areas which puddle water.
 - 5. Areas which are not properly prepared to receive Architectural finish materials. If necessary, the Contractor, at his own expense, shall have the Testing Agency perform appropriate tests for bond and discoloration.
 - 6. Patches that become crazed, cracked or sound hollow when tapped.
 - 7. Self-leveling concrete topping that has cracked, spalled and/or not performed in accordance with manufacturer's design criteria.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS AND PRODUCTION

- A. Blended Hydraulic Cement:
 - 1. ASTM C595, Type II, Portland-Limestone Cement
 - 2. ASTM C595, Type IS, Portland-Slag Cement
 - 3. ASTM C595, Type IP, Portland-Pozzolan Cement
 - 4. ASTM C595, Type IT, Ternary-Blended Cement
- B. Portland Cement:
 - 1. ASTM C150, Type I or Type II
 - 2. ASTM C150, Type III, High-early Strength Portland Cement may be used subject to review and approval of the SER. The specified 28-day concrete compressive strength shall occur within 7 days for concrete using Type III Portland Cement.
 - 3. Provide the same brand of Portland Cement produced in the United States from a single source throughout the project, as required to meet Design Professionals' requirements.

4. Provide Portland Cement that is uniform in color.
- C. Blended Hydraulic Cement:
1. ASTM C595, Type II, Portland-Limestone Cement
 2. ASTM C595, Type IS, Portland-Slag Cement
 3. ASTM C595, Type IP, Portland-Pozzolan Cement
 4. ASTM C595, Type IT, Ternary-Blended Cement
 5. ASTM C595, Type IT (MS) for Exposure Class S1
 6. ASTM C595, Type IT (HS) for Exposure Class S2
 7. ASTM C595, Type IT (HS) plus pozzolan or slag cement for Exposure Class S3]
- D. Aggregates for Normalweight Concrete:
1. ASTM C 33
 2. Fine Aggregate: Natural sand, or sand prepared from stone or gravel, clean, hard, durable, uncoated and free from silt, loam and clay.
 3. Provide aggregates from a single source throughout the project for exposed concrete.
 4. The acceptability of aggregates for the work will depend on proof that their potential alkali reactivity is not deleterious to the concrete.
 5. Do not use fine or coarse aggregates that contain substances that cause spalling.
 6. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301 but shall not exceed the following:
 - Size no. 57 (25mm max) for footings, drilled piers and caissons
 - Size no. 67 (20mm max) for all other locations
 - Size no. 467 or 457 for non-reinforced concrete at locations noted on Drawings.
 7. Contractor shall furnish concrete with maximum 3/8" (10mm) aggregate at no additional cost to the Owner if areas of high reinforcement density require it for placement and consolidation.
- E. Aggregates for Lightweight Concrete:
1. ASTM C 330: Except aggregates prepared by processing natural materials, such as pumice, scoria, or tuff.
 2. Classification of Aggregates: As required to meet Design Professional's requirements.
 3. Provide aggregates from a single source throughout the project for exposed concrete.
 4. Aggregate shall contain the minimum absorbed moisture content recommended by the manufacturer for the project prior to batching.
 5. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301 but shall not exceed 3/4" (20mm)
- F. Water: ASTM C 1602. Clean, and free from injurious amounts of oil, acids, alkali, salts, organic material, or other deleterious materials.
- G. Supplementary Cementitious Material
1. Fly Ash: ASTM C 618, Class C or Class F.
 2. Slag Cement: ASTM C 989.

3. Silica Fume (Microsilica): ASTM C1240.
 - a) Acceptable Products:
 - i. Force 10,000 D by GCP Applied Technologies, Inc.
 - ii. Eucon MSA by Euclid Chemical Company
 - iii. MasterLife SF 100 by Master Builders Solutions
 - iv. Sikacrete 950 DP by Sika Corporation
 4. Metakaolin: ASTM C 618, Class N.
 - a) Acceptable Products:
 - i. MasterLife MK828 by Master Builders Solutions
 - ii. HRMK 100 by GCP Applied Technologies, Inc.
 - iii. Sikacrete M-100 by Sika Corporation
 5. For concrete assigned to Exposure Classes F1 and F2, as defined in ACI 318, there is no limit to the maximum amount of supplementary cementitious materials included in the mix as a percentage of total cementitious materials by mass.
 6. For concrete assigned to Exposure Class F3 as defined in ACI 318, limits to the maximum amount of supplementary cementitious materials included in the mix as a percentage of total cementitious materials by mass are as follows:
 - a) Fly ash or other pozzolans conforming to ASTM C618 = 25%
 - b) Slag cement = 50%
 - c) Silica fume = 10%
 - d) Total of fly ash or other pozzolans and silica fume = 35%
 - e) Total of fly ash or other pozzolans, slag cement and silica fume = 50%
 - f) The maximum percentage limits listed above shall include the supplementary cementitious materials used in the manufacture of ASTM C595 blended cements.
 7. The fly ash or natural pozzolan supplier shall have an effective quality control program in place to guard against contamination of the fly ash and assure compliance with Specifications.
 8. Supplementary Cementitious Materials shall be from one source throughout the project. Substitution of sources will be acceptable only if testing of concrete mixes containing the substituted material show similar test results and if the color of concrete produced with the substituted material matches the color of previously poured concrete to the satisfaction of the Architect.
- H. Ready Mixed Concrete:
1. Shall be batch-mixed and transported in accordance with ASTM C 94.
- I. Self-Consolidating Concrete:
1. Produce in accordance with ACI 237R.
 2. Perform the following tests and provide report prior to submitting mix design:

- a) Resistance to Segregation: Achieve a maximum static segregation percentage of 15% when tested according to ASTM C 1610 with a VSI index of 1 maximum.
- b) Slump Flow: ASTM C 1611 within a range of 20"-30" (500mm-750mm).
- c) Passing Ability: ASTM C 1621 with a maximum difference of 2" (50mm) between testing with and without the J-Ring.

2.2 CONCRETE MIX DESIGN

A. Concrete Strength:

1. Shall be as indicated on the Structural Drawings
2. Where concrete strength is not indicated on the drawings, the minimum concrete strength for exposure classes as defined in ACI 318 are as follows:
 - a) F0, S0, W0, C0, C1 = 2500 psi
 - b) F1 = 3500 psi
 - c) S1, W1 = 4000 psi
 - d) F2, S2, S3, = 4500 psi
 - e) F3, C2 = 5000 psi

B. Concrete Density (Unit Weight):

1. Shall be as indicated on the Structural Drawings

C. Air Entrainment

1. For concrete exposed to freeze/thaw cycles and/or deicing chemicals (ACI 318 Exposure Classes F1, F2, F3), and concrete intended to be watertight, provide entrained air content of $6\% \pm 1.5\%$, unless specified otherwise. This includes, but is not limited to, concrete at the following locations:
 - a) Concrete at the exterior of the structure with at least one surface exposed to weather, such as exterior face of grade beams, foundation walls, exterior walls and parapets, exposed columns and edge beams.
 - b) Floor framing and ramps in parking garages.
 - c) Loading docks.
 - d) Balconies and terraces with no waterproofing membrane.
2. For lightweight concrete less than 120 pcf (19 kN/m^3) density, air content may be up to 7% regardless of exposure condition.
3. For concrete with a specified compressive strength (f_c) greater than 5000 psi (35MPa), required air content may be reduced to $5\% \pm 1.5\%$.
4. Entrained air content noted above shall occur at point of delivery.
5. No entrained air content is required for foundations with no surface exposed to weather.
6. All interior steel trowel finished, normal weight slabs shall have a maximum air content of 3%.

D. Water-Cementitious Material Ratio (w/cm) for Normalweight Concrete

1. The total combined weight of Portland cement and all other supplementary cementitious material shall be used to determine the w/cm.

2. The w/cm shall not exceed the values indicated below, including any water added to meet specified slump in accordance with the requirements of ASTM C 94.
3. Based on Exposure Class, as defined in ACI 318, the following maximum w/cm shall be provided:
 - a) Exposure Class F0, S0, W0, C0, C1, no maximum
 - b) Exposure Class F1, max w/cm=0.55
 - c) Exposure Class S1, W1, max w/cm=0.50
 - d) Exposure Class F2, S2, S3, max w/cm=0.45
 - e) Exposure Class F3, C2, max w/cm=0.40
4. Concrete to receive a polished finish shall have a maximum w/cm ratio of 0.45.

E. Slump

1. Concrete design mixes shall be proportioned to meet the following slump limitations. Slump should be measured as described in the Testing Agency responsibilities:
 - a) Concrete with high range or mid range water-reducing admixture: Concrete slump prior to addition of high range water-reducing admixture shall not exceed 3" +/- 1" (75mm) for normalweight concrete and 4" +/- 1" (100mm) for lightweight concrete. After addition of water-reducing admixture, the concrete shall have a maximum slump of 9" +/- 1" (225mm) unless otherwise approved by the SER.
 - b) Concrete without a water-reducing admixture: Slump shall not exceed 4" +/- 1".

F. Self-Consolidating Concrete Slump/Flow: Use for concrete exposed to view and heavily reinforced areas where indicated on the plans, and where conventional mixtures do not provide adequate consolidation. Minimum slump/flow diameter of **[20" (500mm)]** or as required by the successful test placement onsite, which shall verify proper workability, finish, and setting time. All self-consolidating concrete shall contain the specified high range water-reducing admixture. All self-consolidating concrete shall contain viscosity modifying admixture as required unless proper quantity and grading of fines can be achieved.

G. Chloride Ion Content

1. The total water-soluble chloride ion content of the mix including all constituents shall not exceed the limits defined in ACI 318 unless corrosion inhibiting admixtures are added to the mixture to offset the additional chloride.
2. If the specified level of water-soluble chloride ion content cannot be maintained, appropriate level of corrosion inhibiting admixture shall be added to the mix in accordance with the manufacturer's recommendation to offset the excess amount of chloride at no additional cost to the Owner.

2.3 ADMIXTURES

A. General:

1. Admixtures specified below can be used only when established in the mix design with Design Professionals' prior written approval.

2. Each admixture approved by Design Professionals shall be used in strict compliance with manufacturer's published instructions.
 3. Concrete supplier shall certify all admixtures to be compatible with each other. (See Submittals Section in Part 1)
- B. Air Entraining Admixture:
1. ASTM C 260
 2. Acceptable Products:
 - a) MasterAir Series by Master Builders Solutions
 - b) Darex Series or Daravair Series by GCP Applied Technologies, Inc.
 - c) EUCON AEA -92 or EUCON Air Series by Euclid Chemical Company
 - d) AIR Series or AEA-14 by Sika Corporation
- C. Water-Reducing Admixture:
1. ASTM C 494, Type A
 2. Acceptable Products:
 - a) MasterPozzoloth Series by Master Builders Solutions
 - b) EUCON NW or EUCON WR 91 by Euclid Chemical Company
 - c) WRDA Series, Zyla Series or Mira Series by GCP Applied Technologies, Inc.
 - d) Plastocrete Series by Sika Corporation
- D. Retarding Admixture:
1. ASTM C 494, Type B
 2. Acceptable Products:
 - a) MasterSet R Series or MasterSet DELVO Series by Master Builders Solutions
 - b) EUCON RETARDER 100 by Euclid Chemical Company
 - c) Daratard 17 by GCP Applied Technologies, Inc.
 - d) Plastiment Series by Sika Corporation
- E. Non Corrosive Accelerating Admixture:
1. ASTM C 494, Type C
 2. Acceptable Products:
 - a) MasterSet FP 20 or MasterSet NC 534 by Master Builders Solutions
 - b) ACCELGUARD 80, ACCELGUARD NCA or ACCELGUARD 90 by Euclid Chemical Company
 - c) Daraset[®] Series, Polarset, or DCI by GCP Applied Technologies, Inc.
 - d) Sikaset Series or Rapid-1 by Sika Corporation
- F. Water-Reducing and Retarding Admixture:
1. ASTM C 494, Type D
 2. Acceptable Products:

- a) MasterSet R Series or MasterSet DELVO Series by Master Builders Solutions
 - b) EUCON RETARDER 75 or EUCON DS by Euclid Chemical Company
 - c) Daratard 17 or Recovery Series by GCP Applied Technologies, Inc.
 - d) Plastiment Series by Sika Corporation
- G. Water-Reducing and Accelerating Admixture:
- 1. ASTM C 494, Type E
 - 2. Acceptable Products:
 - a) MasterSet FP 20 by Master Builders Solutions
 - b) ACCELGUARD 80 or ACCELGUARD 90 by Euclid Chemical Company
 - c) Libricon NCA by GCP Applied Technologies, Inc.
 - d) Sikaset NC by Sika Corporation
- H. Mid-Range Water-Reducing Admixture:
- 1. ASTM C 494, Type A
 - 2. Acceptable Products:
 - a) MasterPolyheed Series by Master Builders Solutions
 - b) Daracem or Mira by GCP Applied Technologies, Inc.
 - c) Sikaplast Series or Sikament Series by Sika Corporation
 - d) Eucon MR or Eucon MRX by Euclid Chemical Company
- I. High-Range Water-Reducing Admixture:
- 1. ASTM C 494, Type F
 - 2. Acceptable Products:
 - a) MasterGlenium Series by Master Builders Solutions
 - b) EUCON 37 or PLASTOL SERIES by Euclid Chemical Company
 - c) Daracem or ADVA Series by GCP Applied Technologies, Inc.
 - d) Viscocrete Series or Sikament Series by Sika Corporation
- J. High-Range Water-Reducing Admixture for production of Control Flow Concrete:
- 1. ASTM C494 Type A and F and ASTM C1017 Type I
 - 2. Acceptable Product:
 - a) CONCERA SA8080 by GCP Applied Technologies, Inc.
- K. High-Range Water-Reducing and Retarding Admixture:
- 1. ASTM C 494, Type G
 - 2. Acceptable Products:
 - a) EUCON 537 by Euclid Chemical Company
 - b) Daracem Series or Adva Series by GCP Applied Technologies, Inc.
- L. Workability Retaining Admixture:

1. ASTM C494, Type S
 2. Acceptable Products:
 - a) MasterSure Z-60 by Master Builders Solutions
 - b) Visco Flow-2020 by Sika Corporation
- M. Permeability-Reducing Admixture:
1. ASTM C494, Type S
 2. Shall be a Portland cement based crystalline capillary waterproofing admixture that reacts in concrete to form non-soluble crystalline hydration products in the capillary pores of concrete,
 3. Acceptable Products:
 - a) MasterLife 300D and 300C by Master Builders Solutions
 - b) Eucon Vandex AM-10 by Euclid Chemical Company
 - c) Admix C-Series by Xypex
- N. Viscosity Modifying Admixture (VMA) for Self-Consolidating Concrete (SCC):
1. ASTM C 494, Type S
 2. Acceptable Products:
 - a) MasterMatrix VMA Series by Master Builders Solutions
 - b) V-MAR3 by GCP Applied Technologies, Inc.
 - c) EUCON ABS or EUCON WO or VISCTROL by Euclid Chemical Company
 - d) Sika Stabilizer-4R by Sika Corporation
- O. Corrosion Inhibiting Admixtures:
1. Calcium Nitrite Based: ASTM C 1582 and ASTM C 494, Type C, 30% + 2% solution
 - a) Acceptable Products:
 - i. DCI or DCI-Sby GCP Applied Technologies, Inc.
 - ii. MasterLife CI 30 by Master Builders Solutions
 - iii. EUCON CIA by Euclid Chemical Company
 - iv. Sika-CNI by Sika Corporation
 2. Amine Carboxylate Based: ASTM C 1582, which includes ASTM C-494 amine carboxylate
 - a) Acceptable Product:
 - i. MCI 2005, MCI 2005 NS, MCI 2006 or MCI 2006 NS by Cortec Corporation
 3. Amino Alcohol Based:
 - a) Acceptable Product:

- i. FerroGard 901 by Sika Corporation
- ii. MasterLife CI 222 by Master Builders Solutions

P. Shrinkage Reducing/Compensating Admixtures:

1. ASTM C 494, Type S
2. Acceptable Products:
 - a) Eclipse Floor 200 or Eclipse 4500 (for use with air-entrained concrete) by GCP Applied Technologies, Inc.
 - b) Conex or EUCON SRA Floor or EUCON SRA-XT (for use with air-entrained concrete) by Euclid Chemical Company
 - c) MasterLife SRA Series or MasterLife CRA 007 by Master Builders Solutions
 - d) SikaControl 75 by Sika Corporation
 - e) PREVent-C by PremierCPG

Q. Alkali-Silica Reaction Inhibiting Admixture:

1. ASTM C 494, Type S
2. Shall contain a nominal lithium nitrate content of 30 percent.
3. Dosage to be determined in accordance with US Army COE CRD-C662
4. Acceptable Products:
 - a) MasterLife ASR 30 by Master Builders Solutions
 - b) Eucon Integral ARC by Euclid Chemical Company
 - c) RASIR by GCP Applied Technologies

R. Porosity Inhibiting Admixture:

1. ASTM C494, Type S
2. Sodium silicate free
3. Manufacturer must be able to provide a flooring adhesion guarantee and life of the concrete vapor transmission warranty. In order to obtain warranty, product must be installed in compliance with the manufacturer's published data sheet including but not limited to proper on-site representation, mix design review, concrete testing and installation of vapor retarder for slabs on ground.
4. Acceptable Products:
 - a) Barrier One by Concrete Moisture Solutions, Inc.
 - b) MVRA 900 by ISE LOGIK Industries

S. Carbon Dioxide (CO₂) Mineralization:

1. Where called for on the drawings or when approved by the SER, provide concrete that has undergone carbonization treatment with carbon dioxide (CO₂) during mixing, such that CO₂ is chemically mineralized into the concrete.
2. CO₂ injected into the mix must be post-industrial CO₂ sourced from a nearby emitter. Provide concrete producer's certificate outlining quantity, location and supplier of CO₂.
3. Acceptable Product:
 - a) Carbon Cure by CarbonCure Technologies.

2.4 ADHESIVES

- A. Epoxy Bonding Agent for bonding hardened concrete to hardened concrete (existing concrete damp or dry, at least 28 days old, no surface water):
1. ASTM C 881 Type IV, Grade 1, 2 or 3, Class B or C as appropriate for field temperature conditions.
 2. Acceptable Products:
 - a) Dural 452 Series by Euclid Chemical Company
 - b) Rezi-Weld 1000 by W. R. Meadows
 - c) Sure Bond J58 by Dayton Superior
 - d) SpecPoxy 1000, 2000, 3000, or 3000FS by SpecChem
- B. Epoxy Bonding Agent for bonding freshly mixed concrete to hardened concrete (existing concrete damp or dry, less than 28 days old, no surface water):
1. ASTM C 881, Type V, Grade 1, 2, or 3, Class B or C as appropriate for field temperature conditions.
 2. Acceptable Products:
 - a) Dural 452 Gel or 452 MV by Euclid Chemical Company
 - b) Sikadur 32 Hi-Mod by Sika Corporation
 - c) Rezi-Weld 1000 by W. R. Meadows
 - d) Sure Bond J58 by Dayton Superior
 - e) SpecPoxy 1000, 2000, 3000, or 3000FS by SpecChem
- C. Anti-Corrosive Epoxy Modified Cementitious Bonding Compound and Corrosion Protection of Reinforcement (bonding agent for existing concrete saturated surface dry, no surface water):
- This adhesive shall be a water-based epoxy/cementitious compound for adhesion and corrosion protection of reinforcing members (24 hour maximum open time).
1. Acceptable Products:
 - a) DURALPREP AC by Euclid Chemical Company
 - b) ARMATEC 110 EpoCem by Sika Corporation
 - c) MasterEmaco P124 by Master Builders Solutions
 - d) Perma Prime 3C by Dayton Superior
 - e) SpecPrep SB by SpecChem

2.5 CURING COMPOUNDS AND SEALERS

- A. Interaction with finishes:
1. See architectural Drawings for finish material applied over concrete.
 2. Use only curing and sealer compounds that are compatible with finish, waterproofing or roofing material.
- B. Curing and Sealing Compound (VOC Compliant, 350 g/l) :
1. ASTM C1315, Type I, Class A and/or ASTM C 309, Type 1, Class A or B

2. Water based acrylic, clear, 25% solids curing and sealing compound.
 3. Acceptable Products:
 - a) Super Diamond Clear VOX by Euclid Chemical Company
 - b) Cure & Seal 1315 J22WB by Dayton Superior
 - c) VOCOMP-25 by W. R. Meadows
 - d) Dress & Seal WB 30 or Lumiseal WB by Laticrete International, Inc.
 - e) **[MasterKure CC 1315WB by Master Builders Solutions]**
 - f) Cure & Seal WB 25 by SpecChem
- C. Curing Compound-Dissipating/Strippable (VOC Compliant, 350 g/l):
1. ASTM C 309, Type I, Class A or B
 2. Water based resin, clear curing compound that begins to dissipate when exposed to UV light and traffic.
 3. Acceptable Products:
 - a) Kurez DR VOX by Euclid Chemical Company
 - b) Clear Resin Cure J11W by Dayton Superior
 - c) 1100 by W. R. Meadows
 - d) Spec Rez by SpecChem
- D. Curing and Durability-Increasing Compound, Spray Applied
1. Shall conform to state and federal VOC regulations with zero VOC content.
 2. Not to be used with Moisture Vapor Reducing Admixtures, Integral Waterproofing Admixtures, or Latex Admixtures
 3. Acceptable Products:
 - a) P3 Protect by Spray-Lock Concrete Products
- E. Surface Applied Vapor Emission Mitigation
1. Shall conform to state and federal VOC regulations with zero VOC content.
 2. Shall provide a 15 year warranty against flooring failure due to negative-side moisture vapor migration of moisture-born alkalinity.
 3. Acceptable Products:
 - a) CS2000 by Creteseal
 - b) SCP 327 by Spray-Lock Concrete Protection
- F. Liquid Densifier/Sealer:
1. The liquid densifier compound shall be a silicate based compound that penetrates and chemically hardens concrete surfaces.
 2. Acceptable Products:
 - a) Euco Diamond Hard by Euclid Chemical Company
 - b) Acceptable Product: Dayton Superior "Densifier J13"
 - c) MasterKure HD 200WB by Master Builders Solutions
 - d) Liqui-Hard by W. R. Meadows

G. Evaporation Retarder:

1. Acceptable Products:
 - a) MasterKure ER50 by Master Builders Solutions
 - b) Eucobar by Euclid Chemical Company
 - c) Sika Film by Sika Corporation

2.6 DRY SHAKE HARDENERS

A. Mineral Aggregate Hardener:

1. The specified mineral aggregate hardener shall be a factory-blended mixture of specially processed graded non-metallic aggregate.
2. Acceptable Products:
 - a) Euclid Chemical Company, "Surflex" to be used with "Kurez DR VOX"
 - b) MasterTop 100 to be used with "MasterKure CC 200WB by Master Builders Solutions
 - c) Quartzplate FF to be used with Dress & Seal WB 30 by Laticrete International, Inc.

B. Non-Oxidizing Metallic Hardener:

1. The specified non-oxidizing metallic floor hardener shall be a mixture of specially processed non-rusting aggregates.
2. Acceptable Products:
 - a) Euclid Chemical Company, "Diamond-Plate" to be used with "Kurez DR VOX"
 - b) MasterTop 210COR to be used with "MasterKure CC 200WB by Master Builders Solutions
 - c) Emeryplate FF to be used with Lumiseal WB by Laticrete International, Inc.

2.7 MISCELLANEOUS CONCRETE AND CONCRETE RELATED PRODUCTS

A. Cementitious Non-Shrink Grout:

1. Provide pre-packaged high-precision, non-shrink, non metallic grout.
2. See General Notes for grout minimum compressive strength.
3. ASTM C 1107
4. Acceptable Products:
 - a) MasterFlow 928 by Master Builders Solutions
 - b) Dry Pack Grout or HI-FLOW GROUT by Euclid Chemical Company
 - c) Five Star Grout by Five Star Products
 - d) Sikagrout 328 by Sika Corporation
 - e) Duragrout by Laticrete International, Inc.
 - f) SC Multipurpose Grout or SC Precision Grout by SpecChem

B. Self-Leveling Concrete Topping - Underlayment for Interior Applications:

1. Use self-leveling underlayment concrete formulated to level concrete floors without shrinking, cracking or spalling, and capable of being placed from feathered edge to

1" (25mm) thickness without aggregate in one pour. If greater than 1" (25mm) thickness is required, aggregate shall be extended with aggregate in accordance with manufacturer's requirements. Appropriate primer shall be utilized for all underlayment applications.

2. Acceptable Products:

- a) K-15 by Ardex
- b) Flo-Top or Super Flo-Top by Euclid Chemical Company
- c) Sika Level Series by Sika Corporation
- d) SpecFlow by SpecChem

C. Moisture-Retaining Covers:

1. ASTM C171

2. A naturally colored, non-woven polypropylene fabric with a non-perforated reflective polyethylene coating containing stabilizers to resist degradation from ultraviolet light. Fabric shall exhibit low permeability and high moisture retention.

3. Acceptable Products:

- a) Hydracure S-16 by PNA Construction Technologies, Inc.
- b) Transguard 4000 by Amorlon a Division of Reef Industries , Inc.
- c) UltraCure NCF by Sika Corporation
- d) Top Cure by Transshield

D. Expanded Polystyrene (EPS) used as Fill - Geofoam

1. Material: Rigid, closed cell polystyrene blocks formed by expansion of polystyrene beads by steam.

2. Comply with the requirements of ASTM D 6817

3. Unless noted otherwise on the drawings, provide the following types of EPS:

- a) Fill between a lower slab and a raised slab area: EPS12 -2.2 psi (15 kPa) compressive resistance minimum at 1% deformation, 10 psi (70 kPa) flexural strength minimum
- b) Fill below exterior floor slabs or slabs with truck loading: EPS19 - 5.8 psi (40 kPa) compressive resistance minimum at 1% deformation, 30 psi (200 kPa) flexural strength minimum

4. Thickness as indicated on Drawings.

5. Execution: Conform to manufacturer's instructions regarding preparation, installation and protection

6. Gripper plates shall be used as needed to restrain EPS from moving laterally in multi-layer applications

7. Contractor shall sequence soil or concrete topping placement to avoid EPS block shift or flotation.

8. Submit the following for review:

- a) Manufacturer's product literature including physical properties in compliance with ASTM D 6817 and type specified
- b) 10 year physical property warranty

- c) Proposed plan layout of fill blocks showing gaps between blocks where required for stabilizing and/or load bearing reinforced concrete ribs as shown on drawings, in details or in notes.
 - 9. Submit the following for record:
 - a) Summary of test compliance with specified performance characteristics and physical properties
 - b) Product Certificates showing evidence of third party quality control
 - 10. Acceptable Manufacturers:
 - a) ACH Foam Technologies
 - b) Atlas EPS
 - c) Universal Construction Foam
- E. Vapor Retarder: See Division 7, Thermal and Moisture Protection
 - 1. Minimum 15-mil thick polyolefin membrane
 - 2. Manufactured with prime virgin resins
 - 3. Water Vapor Retarder: ASTM E 1745, meets or exceeds Class A
 - 4. Water Vapor Transmission Rate: ASTM E 96, 0.008 gr./ft²/hr. (0.086 gr./m²/hr) or lower
 - 5. Permeance Rating: ASTM E 96, 0.03 Perms or lower for new material and after conditioning tests in accordance with applicable sections of ASTM E 154
 - 6. Puncture Resistance: ASTM E 1745, minimum 2200 grams
 - 7. Tensile Strength: ASTM E 1745, minimum 45.0 lbs./in (8.0 kg/cm).
 - 8. Acceptable products:
 - a) Floprufe 120 by GCP Applied Technologies, Inc.
 - b) Perminator by W. R. Meadows
 - c) Stego Wrap by Stego Industry LLC
 - d) Raven Vapor Block 15 by Raven Industries
 - e) Husky Yellow Guard 15 Mil by Poly-America]
- F. Non-Slip Aggregate:
 - 1. Abrasive crushed and graded aggregate, high in aluminum oxide aggregate which is unaffected by moisture or cleaning compounds.
 - 2. Acceptable Products:
 - a) Non-Slip Aggregate by Euclid Chemical Company
 - b) Emery Non-Slip by Dayton Superior
 - c) A-H Emery Emerundum by Anti-Hydro International, Inc.

2.8 CONCRETE REPAIR MATERIALS

A. Polymer-Modified Repair Mortar

- 1. The following patching mortars may be used when color match of the adjacent concrete is not required. Prior approval by the Design Professionals is required.
- 2. Acceptable Products-Horizontal Surfaces:

- a) Tammspatch II or Tamms Thin Patch by Euclid Chemical Company
 - b) Sikatop 122 Plus by Sika Corporation
 - c) Meadow-Patch T1 or T2 or Meadow-Crete GPS by W. R. Meadows
 - d) Duracrete by Laticrete International, Inc.
 - e) DuoPatch or Over Crete by SpecChem
3. Acceptable Products-Vertical and Overhead Surfaces:
- a) MasterEmaco N400 by Master Builders Solutions
 - b) Verticoat, Vertacoat Supreme or Dualtop Gel by Euclid Chemical Company
 - c) SikaTop 123 Plus by Sika Corporation
 - d) Meadow-Crete GPS by W. R. Meadows
 - e) Repcon V/O or SpecPatch by SpecChem
- B. Crack Repair:
- a) Euco Qwikstitch or Dural 50 LM by Euclid Chemical Company
 - b) MasterSeal 630 by Master Builders Solutions
 - c) T78 Methyl Methacrylate Crack Sealer by Transpo Industries, Inc.
 - d) Poly Fix by SpecChem
- C. High Strength Flowing Repair Concrete:
1. For forming and pouring large volume repairs, provide shrinkage compensated repair concrete with integral corrosion inhibitor.
 2. Minimum compressive strength 8000 psi (56MPa) @ 28-days
 3. Prior approval by the Design Professionals is required for cold weather applications
 4. Acceptable Products:
 - a) Eucocrete by Euclid Chemical Company
 - b) MasterEmaco S 466 CI by Master Builders Solutions
 - c) Meadow-Crete FNP by W. R. Meadows
 - d) Repcon H-350 by SpecChem
- D. Epoxy Injection:
1. ASTM C881
 2. Acceptable Products:
 - a) MasterInject 1380 by Master Builders Solutions
 - b) Dural Injection Gel by Euclid Chemical Company
 - c) Sikadur 35 LV LPL by Sika Corporation
 - d) Rezi-Weld LV State by W. R. Meadows
 - e) SpecPoxy 1000 by SpecChem
- E. Pressure-Injected Foam Resin:
1. Acceptable Products:
 - a) De Neef Sealform PRe by GCP Applied Technologies
 - b) Crack-Pac Flex-H2O by Simpson Strong-Tie
 - c) SikaFix HH LV by Sika Corporation

- F. Semi Rigid Joint Filler:
1. Acceptable Products:
 - a) MasterSeal CR 190 by Master Builders Solutions
 - b) Euco 700 or Qwikjoint UVR by Euclid Chemical Company
 - c) MM-80 by Metzger/McGuire
 - d) Rezi-Weld Flex by W. R. Meadows
 - e) SpecPoxy CJ or Rapid Flex 90 by SpecChem
- G. Methyl Methacrylate (MMA)
1. Acceptable Products:
 - a) MasterSeal 630 by Master Builders Solutions
 - b) Transpo Industries, Inc. "T-78 Methyl Methacrylate Polymer Crack Healer/Sealer"
 - c) MMA #884 by Epoxy Systems
- H. Sealant:
1. Silicone or Polyurethane Sealant (as selected based on project requirements such as loading, traffic, bond, coatings, etc.).
 2. Joint to be routed and cleaned per manufacturer's written directions.
 3. Acceptable Products:
 - a) MasterSeal Sealants by Master Builders Solutions
 - b) Sikaflex-1C SL and Loadflex 524 EZ by Sika Corporation
 - c) Pourthane NS by W. R. Meadows
 - d) Eucolastic 1NS by Euclid Chemical Company

PART 3 - EXECUTION

3.1 TOLERANCES

- A. Work shall conform to all requirements of ACI 117 except as modified by more stringent requirements in the Project Specifications and/or Drawings.

3.2 PREPARATION

- A. Subgrade:
1. Dampen subgrades not covered with membrane by sprinkling immediately before placing concrete.
 - a) Omit when subgrade is already damp.
 2. Do not place on water-saturated subgrade unless placing can be done without damage to subgrade (surface is stable) and loading the subgrade does not drive free water to the surface.

3. Do not place concrete on frozen ground.
- B. Forms:
1. Coordinate with Section 031000 Concrete Formwork.
 2. Remove dirt, sawdust, nails and other foreign material from formed space.
 3. Dampen wood forms by sprinkling immediately before placing.
 4. Cool metal forms by sprinkling immediately before placing.
- C. Concrete Accessories:
1. Coordinate with Section 031000 Concrete Formwork.
- D. Dewatering:
1. Remove water from concrete formwork.
 2. Divert any flowing water to sump and remove by pumping.
 3. Refer to Division 1 for additional dewatering requirements.
- E. Vapor Retarder Placement: See Division 7, Thermal and Moisture Protection.
1. Vapor retarder installation shall be in accordance with manufacturer's instructions and ASTM E 1643.
 2. Place vapor retarder under slabs-on-grade in position with longest dimension parallel with direction of pour.
 3. Joints: Lap 6" (150mm) minimum and seal with manufacturer's recommended mastic or pressure-sensitive tape.
 4. Prevent damage to moisture barrier.
 5. If moisture barrier is damaged, place a piece of moisture barrier over damaged area (6" (150mm) larger all around) and tape in place with type of tape recommended by moisture barrier manufacturer.
 6. Seal laps and intersections of walls with compatible trowel mastic or pressure-sensitive sealing tape.
 7. Seal around pipes and other penetrations with compatible trowel mastic.
 8. The vapor barrier installation must be approved prior to concrete placement.

3.3 JOINTS IN CONCRETE

- A. Locate construction and contraction joints as indicated on Drawings and on approved joint location submittal.
1. Do not use contraction joints in framed floors or composite slabs.
 2. Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Design Professionals.
 3. Coordinate location of construction and contraction joints with locations of joints in finish materials where they exist.
 - a) Construction and contraction joints in slabs or slab on grade with terrazzo finish must be reviewed and approved by the Design Professionals.
 4. Maximum joint spacing is as indicated on Drawings.

- B. Construction Joints:

1. Construction joints shall be located within the central third of the span. Any concrete spilling over or through the bulkhead shall be removed at the completion of the pour. All surfaces of the concrete shall have reinforcing extending through the joint.
 2. Horizontal Joints: Horizontal construction joints other than those shown on the Drawings will not be permitted unless approved by the Architect.
 3. Joint Preparation: Forms shall be removed in time to permit roughening of construction joints of structural members by chipping and wire brushing to remove all loose and foreign material and roughen as indicated on the Drawings. The existing concrete at joints shall either be (a) dampened to the point that the surface is saturated, but all standing water has been removed, promptly followed by placement and vibration of fresh concrete, or (b) not required to be dampened, with one of the specified bonding compounds applied as appropriate for the joint condition, following manufacturer recommendations, with placement and vibration of fresh concrete to follow while the epoxy bonding agent is still tacky. Joints without epoxy bonding agent require fresh concrete with slump 7 inches (180mm) or greater at horizontal joints, and fresh concrete confined to maintain pressure against the joint at vertical joints. Where such conditions are not present, or where applying water to dampen the surface is impractical, use epoxy bonding agent suitable for dry surfaces
- C. Isolation Joints:
1. Interrupt structural continuity resulting from bond, reinforcement or keyway at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls and other locations, as indicated.
- D. Contraction Joints in Floor Slabs-on-Grade:
1. Maximum slab area controlled by jointing is 400 square feet (35 square meters).
 2. Space joints at 36 times slab thickness unless a smaller spacing is indicated on the Drawings, located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
 3. Contraction joints can be provided by sawcuts, formed joints or appropriately detailed construction joints.
 4. Sawcuts shall be made as soon as possible after slab finishing as may be safely done without dislodging aggregate. The Soff-Cut saw shall be used to a depth of $\frac{1}{4}$ of slab thickness immediately after final finishing. Conventional saw shall be used as soon as possible after final finish without raveling to a depth as indicated on the Drawings.
 5. Where contraction joints coincide with construction joints, detail joint as indicated on Drawings.
- E. Joint Fillers: Coordinate with Section 032000 Concrete Reinforcement and Embedded Assemblies and Division 7 requirements.
- 3.4 MIXING
- A. Measurement of Materials: Conforming to ASTM C 94.
- B. Mixing: All concrete shall be ready-mixed conforming to ASTM C 94 except as follows:

1. Provide concrete materials, proportions and properties as herein specified in lieu of ASTM C 94.
 2. Water, beyond that required by the mix design, shall not be added at the Project site. Addition of water at the Project site shall be made only in the presence of the Testing Agency.
 3. Furnish delivery ticket with each load of concrete delivered to the site to the Contractor conforming to the requirements of ASTM C 94.
- C. High range water reducing agents (superplasticizer), if added at the batch plant, may be added again at the Project site.
1. If superplasticizers are added at the batch plant, the concrete mix design must account for the delivery time, workability, finishability, and setting time required on the jobsite for proper placing and finishing procedures.
 2. If the superplasticizer is redosed at the jobsite in air entrained concrete, air content must be checked after mixing.
- D. Discharge of the concrete shall be completed within 1-1/2 hours , after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. If the 1-1/2 hour limit cannot be achieved due to project location or other project specific conditions, hydration control measures to extend the proper workability up to 4 hours maximum can be proposed for approval by the SER. The increased time period along with redosing of the high range water reducer and/or use of hydration controlling/workability retaining admixtures should be agreed upon at the pre-concrete conference.

3.5 CONCRETE PLACEMENT

A. Prior to Concrete Placement:

1. Mechanical vibrators are required and must be available for placing concrete.
2. Remove debris from space to be occupied with concrete.
3. Notify Design Professionals and Testing Agency 48 hours prior to starting concrete placement.
4. Approved mix designs must be maintained on file in Contractor's Field Office.
5. Reinforcement and accessories shall be in proper locations, clean, free of loose scale, dirt or other foreign coatings that may reduce bond to concrete, and in accordance with Section 032000 and Drawings.
6. Do not place concrete having a slump outside of allowable slump range.
7. Place concrete before initial set has occurred, but in no event after it has been discharged from the mixer more than 30 minutes. All concrete shall be placed upon clean, damp surfaces, free from puddled water, or upon properly consolidated fills or upon Controlled Low-Strength Material with a strength between 50 and 1200 psi. Placement upon soft mud or dry earth is not permitted.
8. Unless adequate protection is provided, concrete shall not be placed during rain.
9. Rain water shall not be allowed to increase mixing water or to damage the surface finish.
10. At surfaces left exposed to view, do not use equipment in placing and finishing concrete that contain aluminum in the finishing edges that come in contact with the concrete surface.
11. Keep subgrade moisture uniform without puddles or dry areas.

12. Place vapor retarder directly below slabs on grade as specified in Contract Documents.
- B. For Conduits and Pipes Embedded in Concrete:
1. For concrete slab, wall, beam or column, conform to requirements of ACI 318. For variations from these requirements, submit a written request for Design Professionals' review and response.
 2. Conduits and pipes shall not be embedded in concrete slabs on steel deck without approval of Design Professional.
 3. Provide sleeves for pipes passing vertically through concrete.
 4. Do not embed aluminum materials.
 5. Do not cut, bend or displace the reinforcement to facilitate placement of embedded pipes and conduits.
- C. Pumping: Pumping shall be done in strict accordance with ACI 304.2R.
- D. Placing Concrete in Forms:
1. Clean and prepare forms as specified in Section 031000/Concrete Formwork.
 2. Place concrete continuously without interruption between predetermined construction and contraction joints in walls.
 3. Deposit concrete in forms in horizontal layers no deeper than 24" (600mm) and in a manner to avoid inclined construction joints.
 4. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
 5. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping.
 - a) Use equipment and procedures for consolidation of concrete in accordance with ACI 309R.
 6. Do not use vibrators to move fresh concrete laterally inside forms from discharge point; shift discharge point as needed.
 7. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine.
 8. Place vibrators to rapidly penetrate placed layer and at least 6" (150mm) into preceding layer.
 9. Do not insert vibrators into lower layers of concrete that have begun to set.
 10. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
 11. Do not vibrate Self-Consolidating Concrete (SCC).
- E. Placing Concrete Slabs:
1. Place concrete continuously without interruption between predetermined construction and contraction joints in floors.
 - a) Place slabs on grade by the long strip cast method. Refer to ACI 302.1R for recommended methods of placement.

2. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
3. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
4. Bring slab surfaces to correct level with a straightedge and strike off.
 - a) Use highway straight edges, bullfloats or darbies to smooth surface free of humps or hollows.
 - b) Do not disturb slab surfaces prior to beginning finishing operations.
5. Maintain reinforcing in proper position on chairs during concrete placement.
6. Do not place materials on slabs or impose loads during period of setting.

F. Placing Concrete on Steel Decks

1. Exercise care during concrete placement on steel decks to prevent concentrated loads or high pile-ups of concrete and to avoid impacts caused by dumping or dropping of concrete on steel decks.
2. Do not use buggies on unprotected areas of deck. If buggies are used to place concrete, furnish and install planked runways to protect deck from damage.

G. Placing Concrete at Construction Joints:

1. To secure full bond at construction joints, surfaces to receive concrete in a subsequent placement shall be left in a roughened state or intentionally roughened by raking while plastic or brushing and chipping immediately after removal.
2. Before new concrete is placed in contact, surfaces of hardened concrete already placed shall be thoroughly cleaned of foreign materials and laitance.
3. At hardened concrete at joints where no bonding agents are used, dampen concrete to achieve a saturated surface dry condition. Leave no standing water. Place and vibrate concrete (slump 7 inches (180mm) or greater) against horizontal joints. Place and vibrate flowing concrete (slump 8 to 10 inches (200 to 250mm)) while maintaining pressure against vertical joints by confinement.
4. At hardened concrete with joints not meeting conditions required for no bonding agents, apply appropriate specified bonding agent for conditions present including age and moisture per manufacturer's specifications. Place new concrete while the bonding agent is still tacky.

H. Floor Topping Slabs:

1. Place concrete topping slab to required lines and levels.
2. Minimum topping slab thickness is 2" (50mm).
3. Place dividers, edge strips and other items to be cast in place.
4. At all topping slabs, remove deleterious material before placing topping slab.
5. All topping slabs shall be bonded unless noted as unbonded on the drawings.
6. Bonded topping slabs should be placed directly against a properly prepared base slab. Proper preparation of the base slab consists of cleaning and removal of all deleterious material roughening the surface to a concrete surface profile of CSP5 or CSP6 and overnight prewetting of the newly cleaned, exposed surface with no standing water present. The surface abrasion method should not cause micro cracking of the top of the base slab.

7. Immediately before placing the bonded topping slab, scrub an even, 1/16" to 1/8" layer of portland cement/sand/water bonding grout over the entire surface to receive the topping slab. Do not allow the bonding grout to dry to a whitish appearance before the topping slab is placed.
8. Where topping slab is noted on Drawings as unbonded the topping should be placed on bond breaker consisting of two sheets of plastic film.
9. Topping mix shall have a maximum water/cement ratio of 0.45.
10. Topping mix shall have a maximum shrinkage of 0.04% at 28 days. If the topping slab is to be exposed and polished, the maximum shrinkage shall be 0.02%.
11. The topping slab shall be moist cured for a minimum of 36 hours after placement.
12. Bonded topping slabs shall have contraction joints located to match any joints in the base slab. All topping slabs shall be jointed to eliminate restraint conditions such as re-entrant corners and to isolate the slab from columns, walls, etc. and to limit the maximum distance between joints to 15 feet (4570mm).

I. Cold-Weather Placement:

1. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306R and as specified in this section.
2. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C), at point of placement.
3. Do not use frozen materials or materials containing ice or snow.
 - a) Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
4. Remove frost, snow and ice from forms, reinforcement and other embedments immediately prior to concrete placement.
5. Use only the specified non-corrosive accelerating admixture previously approved as part of the cold weather mixture. Addition of calcium chloride, salt, thiocyanates or admixtures containing more than 0.05 percent chloride ions is not permitted.
6. Freeze Resistant Concrete per ASTM C1622 and Chapter 9 of ACI 212.3R may be used if approved by SER. The contractor shall prepare a plan for placing, finishing and curing procedures that assure the specified hardened properties are achieved.

J. Hot-Weather Placement:

1. Hot weather is defined as air temperature which exceeds 90°F (32°C) or any combination of high temperature, low humidity and/or high wind velocity which causes a rate of evaporation in excess of 0.2 pounds per square feet per hour (1.0 kg/m² per hour) as determined by ACI 305R.
2. When hot weather conditions exist that would impair quality and strength of concrete, place concrete in compliance with ACI 305R and as specified in this section.
3. Cool ingredients before mixing to maintain concrete temperature at time of placement below 95°F (35°C).
4. Mixing water may be chilled, or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
5. Use of liquid nitrogen to cool concrete is Contractor's option.

6. Fog spray forms, reinforcement, and subgrade just before pouring concrete.
7. When concrete placement will occur late in the day and reinforcing steel will be heated by the sun, cover reinforcing steel with water-soaked burlap so that steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
8. When concrete operations must be performed in direct sun, wind, high temperatures, low relative humidity, or other adverse placing conditions, the specified evaporation retarder shall be applied one or more times during the finishing operation to prevent plastic cracking.

3.6 CONCRETE FINISHES

A. General:

1. Comply with recommendations for concrete finishing established by ACI 302.1R and ACI 304R.
2. Comply with dimensional tolerance limitations given by ACI 117.
3. For shored floor or slab on grade construction: Floor flatness/floor levelness tolerance compliance testing is to be performed prior to the removal of shores and forms but not later than 72 hours of concrete placement by Testing Agency.
4. See architectural Drawings for locations of the various finishes listed below.
5. Comply with the specified overall SOF_F and SOF_L values listed below:
 - a) The specified overall area shall be each individual floor.
 - b) F_F/F_L shall be measured in accordance with ASTM E 1155.
 - c) The specified minimum local values of MLF_F/MLF_L shall be 3/5 of the SOF_F/SOF_L values listed below.
 - d) If an individual test section measures less than either of the specified minimum local MLF_F/MLF_L numbers, that section may be rejected and remedial measures may be required as specified in CONCRETE SURFACE REPAIRS.
 - e) If the composite value of the test surface measures less than either of the specified overall SOF_F/SOF_L numbers, then the entire slab may be rejected and remedial measures may be required.
 - f) F_L numbers shall only apply to supported slabs if the tested with all of the original shoring in place, prior to shoring removal/reshoring.
 - g) F_L numbers shall not apply to unshored slabs or shored slabs with camber.

B. Finish for monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile and other bonded applied cementitious finish flooring material, as indicated on architectural Drawings:

1. Scratch Finish.
 - a) Finish surface to overall value of $SOF_F=20$ and $SOF_L=15$.
 - b) Slope surfaces uniformly to drains where required.
 - c) After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

- C. Finish for monolithic slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, sand-bed terrazzo as indicated on architectural Drawings:
1. Float Finish.
 - a) After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating.
 - b) Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both.
 - c) Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units.
 - d) Finish surfaces to overall value of $SOF_F=20$ and $SOF_L=15$.
 - e) Cut down high spots and fill low spots.
 - f) Uniformly slope surfaces to drains.
 - g) Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- D. Finishes for Pedestrian Sidewalks and Ramps, Exterior Platforms, Steps, as indicated on architectural Drawings:
1. Sidewalks and Curbs: Light-to-medium broom finish applied with fiber-bristle broom perpendicular to direction of main traffic route immediately after float finishing.
 2. Ramps: Scored finish as applied perpendicular to direction of main traffic route immediately after float finishing.
 3. Finish surface to overall value of $SOF_F=20$ and $SOF_L=15$.
 4. Texture shall be approved by the Design Professionals from sample panels.
- E. Finish for interior floor slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, paint or another thin film-finish coating system, as indicated on architectural Drawings:
1. Trowel Finish.
 - a) After floating, begin first trowel-finish operation using a power-driven trowel.
 - b) Begin final troweling when surface produces a ringing sound as trowel is moved over surface.
 - c) The final hand-troweling operation shall result in a smooth surface, free of trowel marks, uniform in texture and appearance.
 - d) Grind smooth any surface defects that would telegraph through applied floor covering system.
 2. Finish surface to overall value of $SOF_F=25$ and $SOF_L=20$.
 3. Floor Slopes: Where drains occur, slope floor slabs uniformly to drains, maintaining scheduled slab thickness.
 4. Floor Edges at Expansion Joints: Tool edges minimum 3/8" (10mm).
 5. Defects: Remove defects of sufficient magnitude to show through floor covering by grinding.
 6. Floor Hardener: Use only where scheduled and in accordance with manufacturer's published instructions.

7. Dry Cement: Shall not be used during finishing.
- F. Finish for thin set ceramic tile or thin set epoxy terrazzo, as indicated on architectural Drawings:
1. Trowel and Fine Broom Finish:
 - a) Apply a trowel finish as specified.
 - b) Immediately follow by slightly scarifying the surface with a fine broom.
 2. Finish surface to overall value of $SOF_F=35$ and $SOF_L=25$.
- G. Finishes for Parking Garage Deck, Ramps, Loading Docks:
1. Highway straight edge immediately after screeding concrete.
 2. Finish surface to overall values of $SOF_F=20$ and $SOF_L=15$. SOF_L should not be tested for parking slabs that include inclined surfaces or planned changes in floor surface slope.
 3. For Slabs Not Receiving Deck Coating: Medium broom finish with ridges not to exceed 1/8" (3mm) in height. Texture shall be as approved by the Design Professionals from sample panels.
 4. For Slabs Scheduled to Receive Deck Coating: Smooth floated finish which must be verified with coating manufacturer before finishing the slab.
 - a) Coordinate with deck coating specified in Division 7.
 5. Auto Ramps: Rough texture applied perpendicular to direction of traffic. Texture shall be as approved by the Design Professionals from sample panels.
- H. Finishes Equipment and Housekeeping Pads
1. Coordinate finish surface to meet equipment manufacturer requirements, if any, for flatness and levelness.
- I. Tolerances at Slab Discontinuities
1. Within 2 ft (600mm) of slab boundaries, construction joints, isolation joints, block-outs, penetrations or other similar discontinuities, where required for travel paths, installation of finishes and partitions, or any other requirements indicated in the Contract Documents, the following equivalent straightedge tolerances shall apply:
 - a) Specified local $MLF_F = 12$, use 1/4" (6mm) over 4 ft (1200mm), no offset greater than 1/16" (2mm)
 - b) Specified local $MLF_F = 15$, use 1/8" (3mm) over 4 ft (1200mm), no offset greater than 1/32" (0.8mm)
- J. Dry Shake Finish:
1. Non-slip aggregate where indicated on Drawings.
 2. Non-oxidizing metallic hardener on loading docks at a rate of 1.5 lbs. per sq. ft. (7.3 kg/m²) and in other locations so noted on the Drawings.
 3. Mineral aggregate hardener at a rate of 1.2 lbs. per sq. ft. (5.8 kg/m²) where noted on the Drawings.

4. Final finish type, method and tolerance as applicable by location and use.
5. Dry shake finish will be applied only where scheduled and in accordance with the manufacturer's published instructions and the methods and procedures agreed upon at the pre-installation conference.

K. Rough Formed Finish:

1. Acceptable for formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated.
2. Concrete surface shall have texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4" (6mm) in height rubbed down or chipped off.

L. Architectural Concrete Finish:

1. Using self-consolidating concrete, provide smooth, uniform finish upon form removal with no patching, stoning or other form of repair except washing permitted unless otherwise noted for walls, columns and other surfaces exposed to view. The surface shall match the approved jobsite mock-up panel.

M. Smooth Formed Finish:

1. Required for formed concrete surfaces exposed to view, or scheduled to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system, as indicated on architectural Drawings:
2. Surface is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
3. Repair and patch tie holes and defects. Remove fins and other projections completely.

N. Smooth Rubbed Finish:

1. "Smooth Rubbed" finish shall consist of a finish free of fins, joint marks smoothed off, blemishes removed and surfaces left smooth and unmarred.
2. Provide smooth rubbed finish to scheduled concrete surfaces, as indicated on architectural Drawings, which have received smooth form finish treatment not later than one day after form removal.
3. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced.
 - a) Do not apply cement grout other than that created by the rubbing process.

O. Grout-Cleaned Finish:

1. Provide grout-cleaned finish on scheduled concrete surfaces, as indicated on architectural Drawings, that have received smooth-formed finish treatment.
2. Combine one part Portland Cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint.
3. Blend standard Portland Cement and white Portland Cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.

4. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes.
5. Remove excess grout by scraping and rubbing with clean burlap.
6. Keep surface damp by fog spray for at least 36 hours after rubbing.

P. Unformed Surfaces:

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

3.7 CURING AND PROTECTION

A. Normal Conditions:

1. Protect concrete from premature drying, excessive hot or cold temperature, and damage.
2. Concrete shall be kept continuously moist and above 50°F (10°C) for seven days (ASTM C 150 Type I cement) or for 10 days (ASTM C 150 Type II cement). High early strength concrete usage shall be maintained over 50°F (10°C) for three days.
3. Concrete and concrete patching materials shall be cured according to manufacturers published recommendations.
4. Begin curing as soon as free water has disappeared from concrete surface and finishing has been completed.
5. Curing Methods: Cure concrete by curing compound, moist curing, moisture-retaining cover curing, or by combining these methods, as specified. Under extreme hot/dry or windy/dry conditions, moist curing and/or moisture-retaining cover curing should be used.

- a) Curing compound is an acceptable form of curing if all of the following requirements are met:
 - i. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). In accordance with all manufacturer's instructions.
 - ii. Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions.
 - iii. Recoat areas subjected to heavy rainfall within 3 hours after initial application.
 - iv. Maintain continuity of coating and repair damage during curing period.
 - v. Use curing and sealing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
 - vi. Floors to receive covering shall be cleaned thoroughly using a power scrubber and industrial strength detergent. Hand-brooming and sweeping is not sufficient.
 - vii. Strippable curing compound may be used in lieu of a moist curing method when approved by the Design Professionals.

- b) Provide moist curing by the following methods:

- i. Keep concrete surface continuously wet by covering with water.
 - ii. Use continuous water-fog spray.
 - iii. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4" (100mm) lap over adjacent absorptive covers.
 - c) Provide moisture-retaining cover curing as follows:
 - i. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" (75mm) and sealed by waterproof tape or adhesive.
 - (1) Immediately repair any holes or tears during curing period using cover material and waterproof tape
 6. Cure slabs on grade, concrete toppings, concrete pour strips, supported slabs, walls and columns, not subject to conditions of hot or cold weather concreting, in accordance with ACI 308.
 7. Cure surfaces exposed to deicing salts, brackish water, etc., such as loading dock slabs, parking garage slabs and ramps in accordance with ACI 308 recommendations for moist curing.
 8. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by leaving forms in place for the full curing period (equivalent to moist curing).
 - a) If forms are removed prior to completion of full curing period, continue curing by methods specified above for Unformed Surfaces, as applicable.
- B. Cold-Weather Protection:
1. When concrete is placed under conditions of cold weather concreting (defined as a period when the mean daily temperature drops below 40°F (4°C) for more than 3 successive days), take additional precautions as specified in ACI 306R when placing, curing, monitoring and protecting the fresh concrete.
- C. Hot-Weather Protection:
1. When concrete is placed under conditions of hot weather concreting, provide extra protection of the concrete against excessive placement temperatures and excessive drying throughout the placing and curing operations with an evaporation retarder.
 - a) Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
 2. Hot weather curing is required if hot weather conditions occur within a 24-hour period after completion of concrete placement.
- D. Floor surfaces, wherever indicated by weather conditions, shall be sprinkled during the interval between finishing operation and the start of curing to positively ensure against the possibility of surface drying.

3.8 CONCRETE REPAIRS

- A. Perform patching and repairs in accordance with ACI 301.
- B. Contractor shall submit patching and repair methods and materials for review by Design Professionals.
- C. When complete, all patches and repairs shall match color and texture of adjoining surfaces.
- D. At surfaces that are exposed to view, prepare test areas at inconspicuous locations for review by Design Professionals to verify repair color and texture match before proceeding with repair.
- E. Apply all patching and repair materials in accordance with manufacturer's specifications.
- F. Repairing Cracks In Formed and Unformed Surfaces:
 - 1. Contractor shall notify Design Professionals of all cracks wider than 0.02" (0.50mm) and all cracks wider than 0.01" (0.25mm) that occur in a group of at least three cracks within twelve inches (300mm), in concrete. If Design Professionals deem repairs necessary, Contractor shall be responsible for repairing all such cracks per Design Professionals recommendation at no expense to the Owner. Repairs will generally require one or more of the following: Epoxy Injection, Semi-Rigid Epoxy, Pressure Injected Foam Resin, Methyl Methacrylate and/or Sealant with joint routed and cleaned. See Concrete Repair Materials section of this Specification for acceptable products
- G. Repairing Formed Surfaces
 - 1. Immediately after stripping forms, patch all honeycombing, defective joints, voids, etc. before the concrete is thoroughly dry.
 - 2. Remove all burrs, fins, and ridges before the concrete is thoroughly dry.
 - 3. Remove stains from rust, grease and oils, from release agents, etc.
 - 4. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the Design Professionals.
 - a) Surface defects, include color and texture irregularities, cracks as defined above, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - b) Chip away defective areas, honeycomb, rock pockets, voids over 1/4" (6mm) in any dimension and holes left by tie rods and bolts, down to solid concrete but in no case to a depth less than 1" (25mm) and saw-cut edges to prevent feather edging of fill material.
 - 5. Repair concealed formed surfaces, where possible, containing defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
 - 6. Clean out form tie holes and fill with dry pack mortar or precast cone plugs secured in place with bonding agent.
 - 7. If honeycombing exposes reinforcement, chip to provide clear space at least 3/4" (20mm) wide all around steel to allow proper bond.
- H. Repairing Unformed Surfaces:

1. High and Low areas in concrete surfaces which are in excess of specified tolerances shall be leveled or ground-smooth.
 - a) Correct high areas by grinding after concrete has cured at least 14 days.
 - b) Correct low areas by applying leveling material. Finish leveling material as specified in this section.
 2. Repair surfaces containing defects that affect durability of concrete.
 - a) Surface defects include crazing, cracks as defined above, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
 3. Repair defective areas, except random cracks and single holes not exceeding 1" (25mm) in diameter, by cutting out and replacing with fresh concrete.
 - a) Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4" (20mm) clearance all around.
- I. Filling In: Fill in holes and openings left in concrete for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place.

3.9 EVALUATION AND ACCEPTANCE OF CONCRETE

- A. In accordance with ACI 301, except where otherwise specified.
- B. If, at any time during construction, the concrete resulting from the approved mix design deviates from Specification requirements for any reason, such as lack of workability, or insufficient strength, the Contractor shall have his laboratory verify the deficiency and modify the mix design, until the specified concrete is obtained. Modified mix to be submitted for approval per Part 1 - SUBMITTALS.

3.10 CORRECTIVE MEASURES

- A. Conflicts: The Contractor shall be solely responsible for errors of detailing, fabrication, and placement of reinforcement steel; placement of inserts and other embedded items; and the structural adequacy of all formwork.
- B. Compensation for Additional Services: Should additional work by Design Professionals such as design, documentation, meetings and/or site visits be required which are necessitated by failure of the Contractor to perform the work in accordance with the Contract Documents either developing corrective actions or reviewing corrective actions developed by others, the Contractor is responsible for paying for additional work performed by the Design Professionals at their standard firm-wide billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

[Balance of page blank; see form on next page]

CONCRETE MIX DESIGN SUBMITTAL FORM

Project: _____
 City: _____
 General Contractor: _____
 Concrete Contractor: _____
 Concrete Strength: _____
 Use/Location on Job: _____
 Supplier's Mix Designation: _____

Design Mix Information

(Please check one):

Refer to ACI 301 for requirements of data used to substantiate strength calculations.

Field Experience (Based on Standard Deviation Analysis): _____
 Trial Mixture Test Data: _____

Design Characteristics:

Density: _____ Pcf (kg/m3)
 Strength: _____ Psi (MPa) (28 day)
 Air: _____ % (specified)

Materials:	Type/Source	Specific Gravity	Weight (lb)	Absolute Vol. (cu. ft.) (cu. m)
Cement:				
Fly ash:				
Slag (GGBFS)				
Microsilica:				
Coarse Aggregate:				
Fine Aggregate:				
Water:				
Air:				
Other:				
TOTAL:				27.0 cu. ft. (1.0 m3)
Water/Cementitious Material Ratio (lbs. (kg) water / lbs. (kg) cementitious material) =				%

Admixtures:	Manufacturer	ASTM	Dosage (oz/cwt)
Water Reducer:			
Air Entraining Agent:			
High Range Water Reducer			
Non-corrosive Accelerator:			
Other:			

Slump before HRWR: _____ Inches (mm)
 Slump after HRWR: _____ Inches (mm)

Standard Deviation Analysis (from experience records):

No. of Test Cylinders	_____
Evaluated:	_____
Standard Deviation:	_____

Required Average Strength f_{cr}

Average Strength by Tests

Equation Used (ACI Chapter 5)

(Refer to ACI 318 for increased deviation factor when less than 30 tests are available)

TRIAL MIXTURE TEST DATA

Compressive Strength:	Age (days)	Mix #1	Mix #2	Mix #3
	28 [56] [90]	psi (MPa)	psi (MPa)	psi (MPa)
	28 [56] [90]	psi (MPa)	psi (MPa)	psi (MPa)
	28 [56] [90]	psi (MPa)	psi (MPa)	psi (MPa)
	Average	psi (MPa)	psi (MPa)	psi (MPa)
<i>Required Average Strength f_{cr}</i>				
<i>Average Strength by Tests</i>				
<i>Equation Used (ACI Chapter 5)</i>				

REQUIRED ATTACHMENTS

Please check

Coarse Aggregate Gradation Report	
Fine Aggregate Gradation Report	
Fly Ash (or other Supplementary Cementitious Material) Certification	
Concrete Compressive Strength Data or Trial Mixture Test Data	
Admixture Compatibility certification letters	
Chloride Ion Content Certification	
Alkali Aggregate Reactivity Certification	
Shrinkage Test Reports	

SUBMITTED BY:

Name: _____

Address: _____

Phone no.: _____

Main Plant Location: _____

Miles from Project: _____

Secondary Plant Location: _____

Miles from Project: _____

Date: _____

Certification by Concrete
Supplier: _____
Signature: _____

Print Name: _____

PE License Number
and Expiration Date
(print or stamp) _____

Structural Substitution Request Form – to be completed by Contractor

Project:		Substitution Request #
Date:		
Requesting Contractor:		Pages Attached (including this form)

1. Description of Requested Substitution:

2. Related Drawings and Specification Sections:

3. Rationale or Benefit Anticipated:

4. Effect on Construction Schedule¹ (check one): NONE See Attached

5. Effect on Owner’s Cost² attach data (check one): CREDIT TO OWNER EXTRA

6. Effect on Construction Documents³ (design work anticipated): NONE See Attached

7. Requesting Contractor Agrees to Pay for Design Changes (check): YES NO NOT APPLICABLE

8. Effect on Other Trades⁴:

9. Effect of Substitution on Manufacturer’s Warranty (check): NONE See Attachment
 Signature⁵: _____ Date: _____

Company:

General Contractor Signature⁵: _____ Date: _____

Notes:

1. Contractor is responsible for means and methods and any problems that may arise from making the requested substitution.
2. This is **NOT A CHANGE ORDER FORM**. A separate form is required to adjust costs and/or schedules.
3. Contractor is responsible for any design impacts that may arise from this substitution, including redesign efforts.
4. Contractor is responsible for effects on other trades from this substitution;
 General Contractor must review and agree effects on other trades are fairly represented in items 4-9.
5. Signature by a person having authority to legally bind his/her company to the above terms. Otherwise this request is void
6. All items in form must be completed for substitution request to be considered.

Request Review Responses (completed by Architect and/or Engineer(s)):

ACCEPTED	ACCEPTED AS NOTED	REJECTED	INSUFFICIENT DATA TO SUPPORT REQUEST	ENGINEER / ARCH / MEP SIGNATURE	DATE

Engineer/Architect Comments:

END OF SECTION 033000

SECTION 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

The work covered by this Section shall include all labor, material, equipment, permits, engineering and other services necessary for the fabrication and installation of structural steel and related work, complete, in accordance with the Drawings and as specified herein.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 014500
Concrete Reinforcement and Embedded Assemblies	Section 032000
Cast-In-Place Concrete	Section 033000
Steel Deck	Section 053000
Miscellaneous Metals	Division 5
Fireproofing	Division 7
Painting	Division 9
Elevators	Division 14

1.4 CODES AND STANDARDS

- A. Building Code: Structural steel work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.
- B. Standards:
1. American Institute of Steel Construction (ANSI/AISC 360) "Specification for Structural Steel Buildings" per Structural General Notes.
 2. American Institute of Steel Construction (AISC 303), "Code of Standard Practice" (COSP). The 2022 version of the COSP shall apply in lieu of any other version of the COSP referenced by the steel code referenced by the Authority Having Jurisdiction (AHJ).
 - a) Where a conflict exists between the Code of Standard Practice and the Contract Documents, the Contract Documents shall govern.
 - b) For item 1.4, the 2D design drawings govern unless stated otherwise in an executed digital model exchange agreement.

- c) Item 4.4 shall be replaced with the requirements of the project Specifications.
- d) The first sentence of item 4.5 shall be revised from "...fabrication and erection documents shall be delivered to the fabricator in a timely manner" to "...fabrication and erection documents shall be delivered to the fabricator under the terms of the agreement for that work as specified in the contract documents".
- e) The second paragraph of item 7.10.3 shall be revised from "... ODRD or the ODRC" to "ODRC or as indicated in the Contract Documents"

- 3. American Welding Society, AWS D1.1, "Structural Welding Code".
- 4. Research Council on Structural Connections (RCSC) - "Specification for Structural Joints Using High Strength Bolts".
- 5. American Society for Testing and Materials "ASTM Standards in Building Codes", various standards as referenced herein.
- 6. The Society for Protective Coatings (formerly Steel Structures Painting Council, "SSPC") "Steel Structures Painting Manual".

C. Definitions:

- 1. The term "Contract Documents" in this Specification is defined as the design Drawings and the Specifications.
- 2. The term "SER" in this Specification is defined as the Structural Engineer of Record for the structure in its final condition.
- 3. The term "Design Professionals" in this Specification is defined as the Owner's Architect and SER.
- 4. The term "Contractor" in this Specification is defined to include any of the following: General Contractor and their sub-contractors, Construction Manager, Structural Steel Fabricator or Structural Steel Erector.
- 5. The term "Heavy Sections" in this Specification is defined to include hot rolled steel shapes with flanges exceeding 1 1/2 inches (38mm) in thickness and built up cross sections with plates exceeding 2 inches (50mm) in total thickness.
- 6. The term "High Restraint Weld" describes welds in which there is almost no freedom of movement for members joined due to geometry or material thickness.
- 7. The term "Testing Agency" in this Specification is defined as an independent testing and inspection service engaged by the Owner for quality assurance testing and inspection of structural construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.
- 8. The terms "for record" and "submit for record" in this Specification are defined as Contractor submittals that do not require a response from the Design Professionals.
- 9. The term "Working Days" in this Specification is defined as Monday through Friday, except for federal or state holidays.
- 10. The term "Delegated Design" in this Specification is defined as a scope of work that meets performance and design criteria established in the Contract Documents and is to be completed by the Contractor's licensed engineer.

1.5 CONTRACTOR QUALIFICATIONS

- A. Qualification Data: Submit for record qualification data (personnel and firm resumes, and project lists with references) for the Structural Steel Fabricator ("Fabricator"), Structural Steel Detailer ("Detailer"), Contractor's Engineer(s) and Structural Steel Erector ("Erector").

- B. The Fabricator shall have 10 years of comparable experience in installations of this type and shall employ labor and supervisory personnel familiar with the type of installation, experienced in fabrication and erection of structural steel for projects of similar size and complexity. At the time of bid the Fabricator shall be AISC certified to the Standard for Steel Building Structures (BU) and must submit proof of these qualifications. The Fabricator's qualifications shall be subject to review by the Design Professionals and Owner.
- C. The Detailer shall have 10 years experience preparing detailed steel shop drawings and CNC downloads for structures of this type and complexity. The detailer's qualifications shall be subject to review by the Design Professionals and Owner.
- D. The Contractor's Engineer(s) shall be qualified to perform the type of work required by the project. The Engineer shall be a Professional Engineer licensed in the state where the project is located. The Contractor's Engineer(s) shall have 10 years of experience being in responsible charge of work of this nature. The proposed Engineer(s) shall be subject to approval of Design Professionals and Owner.
- E. The Erector shall have 10 years of successful experience erecting structural steel for structures of this type and complexity in the region of the project. At the time of bid the Erector shall be an AISC Certified Erector (CSE) and must submit documentation of this qualification.
- F. Welding: Qualify the welding procedures, shop welders, field welders, welding operators and tackers in accordance with AWS D1.1 and for the following periods of effectiveness of certification:
 - 1. Certification and qualification, including period of effectiveness of welding personnel shall be as specified by AWS D1.1. Certification shall remain in effect for duration of work provided welders are continuously engaged in performing the type of welding for which they are certified, unless welders fail to perform acceptable welding, as determined by the Testing Agency. Certification and re-certification of welding personnel is subject to verification by the Testing Agency. Re-testing for re-certification will be the Contractor's responsibility.

1.6 SUBMITTALS

- A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested. Reproduction of structural drawings for shop drawings is not permitted. Building Information Models for contractor's use may be provided as mutually agreed upon by Design Professionals.

- (1) Submittal Schedule
- (2) Calculations, Shop Drawings and Erection Drawings
- (3) Submittal Letters
- (4) Pre-construction Survey
- (5) Quality Control Program
- (6) Product Data
- (7) Samples
- (8) Welding Procedures Specification (WPS)
- (9) Welder Certifications

- (10) Mill Reports
- (11) As-built surveys

Submittal Schedule: The contractor shall submit for action a typical connection design calculation and shop drawing submission schedule at least twenty (20) working days prior to commencing submission of shop drawings.

- a) This schedule shall include a list, in order of date to be submitted, of all drawings and other required submittal items scheduled to be submitted. The schedule shall list the proposed submittals for each week, including but not limited to the number of calculation sheets, erection drawings, and piece drawings, as well as their formats. Once shop drawing submissions have commenced any modification or addition to this schedule must be submitted for action at least twenty (20) working days before the modification or addition is proposed to take place.
- b) If at any time the total number of connection design calculations, erection drawings and shop drawings received in any one week period exceeds the amount in the approved schedule by more than 10% for that week, the Design Professionals have the right to add two days to the average turnaround time for each 20% increment in excess of the scheduled quantity for that week's submissions. For example if the weekly total exceeds the schedule by 10% to 20%, two days may be added; if it is exceeded by 21% to 40%, four days may be added. The return dates for subsequent submittals may be extended based on the additional review time stated above.
- c) For the purposes of developing a schedule, assume the following review rates:
Calculations – 100 – 8 1/2' x 11" sheets per week
Shop drawings – 300 pieces per week

2. **Shop Drawings and Erection Drawings** (including Field Work drawings): Submit for action required shop drawings and erection drawings for all structural steel indicated on the Contract Documents.

- a) Material shall not be fabricated or delivered before the shop and erection drawings have been approved or approved as noted by the Design Professionals and returned to the Contractor.
- b) Structural Steel Shop Drawings: Submitted shop drawings shall include layouts and details for each member showing the steel type and grade, size, connections, cuts, copes, holes, bolts, welds, surface treatments (cleaning, shop paint, etc.) and provisions for the connection of other work. Steel type, grade and size for all attached elements shall also be shown.
- c) Shop and erection drawings shall contain complete dimensional and geometric information, based on established dimensions shown on Contract Documents, and shall not be scaled from Contract Documents. The shop drawings shall clearly distinguish between shop and field welds and bolts, identify pretensioned high strength bolts and identify surface preparation requirements at slip critical connections.
- d) Welds: All welds shall be indicated by standard welding symbols in "AWS A2.4 "Standard Symbols For Welding, Brazing, And Nondestructive Examination" or as accepted by the SER. Shop and erection drawings shall

- show the size, length, and type of each weld, including the electrode type to be used.
- e) Bolts: Details for bolt assemblies shall indicate bolt size, length, type and the presence, type and location of washers where required as part of the assembly; distinguish between N and X bolts, distinguish between slip-critical and bearing bolts; specify approved slip critical coatings; and distinguish between shop and field bolts. Also, indicate bolt orientation where required by the Contract Documents.
 - f) Erection Drawings: The erection drawings shall include plans showing exact locations of base and bearing plates, and/or anchor rods and other embedded items. All field connections not specifically shown on shop drawings shall be shown on erection drawings, including field bolt size, type, number, location and any special installation requirements, and field weld size, type, length and location.
3. **Preconstruction Survey:** Submit for record. Where interface with existing construction occurs, before related shop drawings are prepared survey the existing construction and submit the survey prepared by a professional surveyor employed by the Contractor to the Design Professionals. For all steel construction, before steel erection commences, perform and submit to the Design Professionals a complete survey for position and alignment at all points where construction by other trades will support steel elements, including but not limited to pockets, embedded plates, anchor rods and base plates. Include plan location positions relative to the building gridlines and elevations of bearing surfaces and tops of bolts relative to building Datum elevation. Immediately notify the SER of elements that are not within tolerance.
4. **Quality Control Program:** Submit for record complete details of the Contractor's quality control program including the names of the personnel responsible for this work.
5. **Product Data:** Submit for action manufacturers' specifications, test reports and applicable standards for all products listed under Part 2: Products. Standard literature shall be edited to suit job conditions.
6. **Samples:** Submit for record (2) samples each, (2) of shop painted products and (2) of field touch-up painted products. Samples shall be steel material.
7. **Welding Procedures:** Submit for record all Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR):
- a) All Welding Procedures shall be Signed and Sealed by the Contractor's Engineer or Certified Welding Engineer, confirming all essential variables meet design requirements as applicable on the Contract Documents and weld electrode manufacturer's recommendations.
 - b) The Contractor's Engineer or Certified Welding Engineer shall develop all Special Welding Procedures for Heavy Sections and High Restraint Welds. Special Procedures shall be Signed and Sealed by the Contractor's Engineer or Certified Welding Engineer. Use of AWS D1.1, Annex E forms are recommended for Special Procedure submittals.
8. **Welder Certification:** Submit for record certification that the welders have passed qualification tests using AWS procedures.
- a) A certification shall be submitted in standard AWS format.

- b) Each certification shall state that the welder has been doing satisfactory welding of the required type within the six-month period prior to the subject work.

For any welder whose period of certification effectiveness has lapsed or whose workmanship is subject to question in the opinion of the Design Professionals or Testing Agency, immediate testing for recertification will be required. Tests, when required, shall be conducted at the sole expense of the Contractor.

- 9. **Mill Reports:** Submit for record certified copies of all mill reports to the Design Professionals and to the Testing Agency, covering the chemical and physical properties of all structural steel and accessories (as defined in this Specification) for the project.

- a) Such certificates shall be obtained from the mills producing the steel and shall certify in a cover letter submitted with the certificates, that the steel meets the minimum requirements as to physical properties, inspection, marking and tests for structural steel as defined by the current edition of the relevant ASTM Standard Specifications. Any steel that does not meet the ASTM requirements must be clearly identified in a cover letter submitted with the certificates.

- b) Prior to commencing steel erection, the contractor shall deliver certificates to the Owner in number and form as may be required by the local Building Department or other local and State agencies having jurisdiction.

- 10. **As-Built Surveys:** Execute and submit for record a comprehensive survey of steel structure at each level adequate to assess if the structure has been built within the tolerances specified in the Contract Documents. Each certified survey, performed by a professional surveyor employed by the Contractor, shall be submitted to the Contractor's Engineer for their approval before proceeding to the next stage of erection. If deviations from the tolerances are discovered, the Contractor shall present corrective measures to the Design Professionals within 48 hours of completion of that stage of erection. Upon completion of steel erection, submit the complete package of steel surveys for record to the Design Professionals and the Owner.

B. Submittal Process

- 1. Submittal of shop and erection drawings and other submittals by the Contractor shall constitute Contractor's representation that the Contractor has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each drawing with other Drawings and other trades. The Contractor shall place their shop drawing stamp on all submittals confirming the above.
- 2. Shop and erection drawings: Submit in complete packages so that individual parts and the assembled unit may be reviewed together. This Specification Section and the applicable drawings used in the development of the shop and erection drawings shall be referenced on each shop and erection drawing to facilitate checking. Unless the piece marks are self-indexing, furnish index sheets with the shop drawings, relating piece marks for all beam, girder and column details to the sheet numbers on which they are located.
- 3. The Contractor shall submit to the Design Professionals one (1) electronic copy for shop drawing review. The naming convention of each drawing must follow the

- submittal numbering system and include the submittal #, specification #, revision # and drawing # in the prefix of the drawing name.
4. The Contractor shall allow at least ten (10) working days between receipt and release by the SER for the review of shop and erection drawings and submittals other than connection design calculations. The Contractor shall allow at least fifteen (15) working days between receipt and release by the SER for the review of connection design calculations.
 5. All modifications or revisions to submittals, shop drawings, connection design calculations and erection drawings must be clouded, with an appropriate revision number clearly indicated. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Design Professionals:
 - a) Failure to specifically cloud modifications
 - b) Failure to submit calculations for the modifications
 - c) Unapproved revisions to previous submittals
 - d) Unapproved departure from Contract Documents
 6. The Contractor shall deliver to the Design Professionals at the completion of the job two (2) electronic versions of the final as-built shop drawings on a CD-ROM or other media acceptable to the Design Professionals.
 7. Resubmittals: Completely address previous comments prior to resubmitting a drawing. Resubmit only those drawings that require resubmittal.
 8. Resubmittals Compensation: The Contractor shall compensate the Design Professionals for submittals that must be reviewed more than twice due to contractors' errors. The Contractor shall compensate the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%.

C. SER Submittal Review

1. The review of connection design and the review and approval of shop and erection drawings and other submittals by the Design Professionals shall be for general conformance with the design intent of the work and with the information given in the Contract Documents only and will not in any way relieve the Contractor or the Contractor's Engineer from:
 - a) Responsibility for all required detailing.
 - b) Responsibility for the proper fitting of construction work in strict conformance with the contract requirements.
 - c) The necessity of furnishing material and workmanship required by contract Drawings and Specifications which may not be indicated on the shop and erection drawings.
 - d) Conforming to the Contract Documents.
 - e) Coordination with other trades.
 - f) Control or charge of construction means, methods, techniques, sequences or procedures, for safety precautions and programs in connection with the work.
2. TYPE 1 – Structural Submittal Review Stamp: For shop drawings for building elements designed by the SER, the responses on the shop drawing review stamp used by the SER require one of the following actions:

- a) APPROVED indicates that the SER has found that the information presented on the shop or erection drawing appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.
 - b) APPROVED AS NOTED indicates that the SER requires the shop or erection drawing to be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected shop or erection drawing for record.
 - c) REVISE and RESUBMIT indicates that the SER requires resubmission of the shop or erection drawing after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.
 - d) NOT APPROVED indicates that the shop or erection drawing does not conform to the Contract Documents and must be extensively revised before re-submittal. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.
3. TYPE 2 – Delegated Design Review Stamp: For submittals for building elements which are not designed by the SER but are delegated design items, or for items that do not form part of the completed structural system but impose loads on the structure, or for construction items or activities which have an effect on the final structure. The responses on the stamp used by the SER require one of the following actions:
- a) NO EXCEPTIONS indicates that the SER has found that the information presented on the submittal appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.
 - b) EXCEPTIONS NOTED indicates that the SER requires the submittal be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected document for record.
 - c) REJECTED indicates that the SER requires resubmission of the submittal after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed. Contractor to revise and resubmit until SER response of No Exceptions or Exceptions Noted is received.

D. Substitution Request

1. Requests for any departure from Contract Documents must be submitted in writing by the Contractor and accepted in writing by the Design Professionals, prior to receipt of submittals.
2. All substitutions must be requested using the structural substitution request form included at the end of this section. Acceptance using the structural substitution request form indicates acceptability of the structural concept only. Contractor must submit shop drawings reflecting accepted substitutions for review in accordance with this Specification. The structural substitution request form, even if accepted, does not constitute a change order.
3. Such substitutions or modifications, if acceptable to the Design Professionals shall be coordinated and incorporated in the work at the sole expense of the Contractor.
4. The acceptance by the Design Professionals of a specific and isolated request by the contractor to deviate from these requirements does not constitute a waiving of that requirement for other elements of, or locations in the project, unless specifically addressed as such and permitted by the Design Professionals in writing.
5. Compensation for Additional Services: Should additional work by Design Professionals such as design, documentation, meetings and/or site visits be required which are necessitated for the review and/or incorporation of the Contractor-requested substitution, including indirect effects on other portions of the work, the Contractor is responsible for paying for additional work performed by the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.
6. Contractor is responsible for means and methods and any impacts on other portions of the work that may arise from this substitution.

E. Request for Information (RFI)

1. RFI shall originate with the Contractor. RFI submitted by entities other than that Contractor will be returned with no response.
2. Limit RFI to one subject.
3. Submit RFI immediately upon discovery of the need for interpretation or clarification of the Contract Documents. Submit RFI within timeframe so as not to delay the Construction Schedule while allowing the full response time described below.
4. The response time for answering an RFI depends on the category in which it is assigned.
 - a) Upon receipt by the SER, each RFI will be assigned to one of the following categories:
 - i. No cost clarification
 - ii. Shown in Contract Documents
 - iii. Change to be issued in future bulletin
 - iv. Previously answered
 - v. Information needs to be provided by others.
 - vi. Request for corrective field work
 - vii. Request for substitution
 - b) RFIs in the first five categories listed above will be turned around by the SER on average of five (5) working days.

- c) RFIs in the last two categories listed above will be immediately rejected and must be submitted as submittals or requests for substitution.

1.7 TEMPORARY SUPPORT OF STRUCTURAL STEEL FRAME

The structure as shown on the Contract Documents is designed to withstand the design loads only when all structural elements are installed and fully connected. The contractor shall be responsible for the analysis of all components and assemblies for stresses and displacements that may be imposed by fabrication, shipping, handling, erection, temporary conditions, construction loads, etc. The analysis of such shall be performed by the Contractor's Engineer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Unload all structural steel promptly upon arrival and store in an area designated and approved by the Owner at the site of the work. The Contractor shall be responsible for any charges from failure to unload material promptly.
- B. Storage: Store structural steel to drain properly. Provide weep holes and clean out as required to keep steel free from water. Provide adequate protection and shoring to prevent distortion and other damage. Store structural steel on timber; do not lay on mud, directly on ground or cinders, or otherwise handle in a manner that damages finishes. Stored sections shall be readily accessible for inspection.
- C. Store fasteners in a protected place.
- D. Welding materials to be in moisture resistant, undamaged package. Maintain packages effectively sealed until electrode is required for use. Storage and handling shall be per AWS D1.1.

1.9 CONNECTION DESIGN AND DETAILING CONFERENCE

- A. At least 20 working days prior to starting connection design and detailing, the Fabricator shall hold a meeting to verify all connection design assumptions and procedures and shop drawing preparation and submittal procedures.
- B. The Contractor shall prepare an agenda and require responsible representatives of every party who is concerned with the connection design and detailing to attend this meeting, including but not limited to:
 - 1. General Contractor
 - 2. Fabricator
 - 3. Detailer
 - 4. Design Professionals
 - 5. Erector
- C. The Fabricator shall prepare an agenda prior to the meeting, and shall distribute meeting minutes to all parties within 5 working days of the meeting.

1.10 STRUCTURAL STEEL PRE-ERECTION CONFERENCE:

- A. At least twenty (20) working days prior to the commencing of steel erection the Contractor shall hold a meeting to review the detailed requirements of the steel erection.

- B. The Contractor shall prepare an agenda and require responsible representatives of every party who is concerned with the steel erection to attend the conference, including but not limited to the following:
 - 1. General Contractor/Construction Manager
 - 2. Steel Erector / Steel Fabricator
 - 3. Erector's Surveyor
 - 4. Roof Deck Contractor
 - 5. All Testing and Inspection Agencies
 - 6. Design Professionals
 - 7. Owner
 - 8. Precast or Cladding Contractor as appropriate.
- C. Minutes of the meeting shall be recorded, typed and distributed by the Contractor to all parties listed above within 5 working days of the meeting.
- D. The minutes shall include a detailed outline of the erection procedure including a schedule of milestone dates for surveys and sign-offs on erection stages which represents an agreement reached by all parties involved. It shall also include the surveying program and submission schedule for approval.
- E. Notwithstanding any provision of the Specification, the SER shall not be responsible for and not have charge over any safety programs or precautions at the site of the Project.

1.11 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. See Section 014500.

1.12 QUALITY CONTROL BY CONTRACTOR

- A. The Contractor shall provide a program of quality control to ensure that the minimum standards specified herein are attained.
- B. The Owner's general review during construction and activities of the Testing Agency are undertaken to inform the Owner of performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.
- C. The Contractor shall immediately notify the Design Professionals of any deficiencies in the work which are departures from the Contract Documents which may occur during construction. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Design Professionals and Owner, the Contractor shall correct the deficiency at no cost to the Owner. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in the OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS section of this Specification.

1.13 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

- A. Observations: The Design Professionals will observe the construction for general compliance with the provisions of the Contract Documents during various phases of construction.

- B. Corrections by Design Professionals: See Part 3 - CORRECTIVE MEASURES section of this Specification.

1.14 PERMITS AND WARRANTY

- A. Permits: The Contractor shall apply for, procure, renew, maintain, and pay for all permits required by City, State, or other governing authorities, necessary to execute work under this Contract. Contractor shall furnish copies of all permits to the Owner and Design Professionals.
- B. Warranty: Comply with General Conditions, agreeing to repair or replace specified materials or work that has failed within the warranty period.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

- A. Structural steel shall conform to the requirements listed on the Structural General Notes.

2.2 SHOP COATINGS

- A. Standard Primer: Rust inhibitive, universal phenolic alkyd metal primer 2-4mls. Color to be determined by Architect. Primer shall be compatible with, and from the same manufacturer as, top coats specified in Division 9 specification.
- B. Zinc Rich Primer: SSPC-Paint 20, Type I or Type II, Zinc rich primer utilizing either an organic or inorganic binder with a minimum zinc content of 80 percent by weight in the dry film. The primer shall provide a surface meeting AISC Slip Critical Class B (slip coefficient =0.50 min) requirements. Color to be determined by Architect. Primer shall be compatible with, and from the same manufacturer as, top coats specified in Division 9 specification.
- C. Hot Dip Galvanizing: ASTM A123, weight of coating shall average not less than 2.3 oz per square foot (0.70 kg/ m²), with no individual thickness less than 2.0 oz per square foot (0.61 kg/m²).
- D. Galvanizing Repair Paint: ZRC Cold Galvanizing Compound, or other coating complying with SSPC-Paint 20.

2.3 ACCESSORIES

- A. High Strength Bolts: Conform to the provisions of the Research Council on Structural Connections (RCSC) "Specification for Structural Joints Using High-Strength Bolts" except that nuts shall be ASTM A563 Grades DH or DH3 (hardened) for both Grade A325 and A490 bolts. Twist-off type bolts (Tension Control bolts) shall conform to ASTM F3125.
- B. All bolts shall be new, and not re-used.
- C. Where Grade A325 galvanized bolts nuts and washers are required, they shall be in accordance with ASTM F2329 and ASTM A153, Class C. Where A588 steel is used, bolts, nuts and washers shall be Type 3.
- D. Direct Tension Indicators: Meet requirements of ASTM F959.

- E. Anchor Rods: Per structural General Notes.
- F. Washers:
 - 1. Round washers shall conform to American Standard B 27.2 type b
 - 2. Washers in contact with high-strength bolt heads and nuts shall be hardened in accordance with ASTM Standard F436.
 - 3. Beveled washers shall be square, smooth and sloped so that contact surfaces of the bolt head and nut are parallel.
 - 4. The diameter of the hole of square beveled washers shall be 1/16 inch (1.5mm) greater than the bolt size for bolts smaller than one inch (25mm), and shall be 1/8 inch (3.0mm) greater than the bolt size for bolts larger than one inch (25mm).
 - 5. Comply with requirements of RCSC for all washers including thickness, size and hardness, depending on connection details.
- G. Welding Electrodes: Electrodes shall be low hydrogen type and shall have material strength matching characteristics (E70, E80, or E90) as selected from AWS D1.1, Table 3.2.
 - 1. Shielded Metal-Arc Welding (SMAW): Welding electrodes for manual SMAW shall have a maximum H4 series level of diffusible hydrogen and conform to the Specification for Carbon Steel Electrodes; AWS A5.1, or the Specification for Low-Alloy Steel Electrodes; AWS A5.5.
 - 2. Gas Metal-Arc Welding (GMAW): Welding electrodes for semiautomatic GMAW shall have a maximum H4 series level of diffusible hydrogen and conform to the Specification for Carbon Steel Electrodes and Rods; AWS A5.18, or the Specification for Low-Alloy Steel Electrodes and Rods; AWS A5.28
 - 3. Flux Core-Arc Welding-Gas Shielding (FCAW-G): Welding electrodes for semiautomatic FCAW-G shall have a maximum H8 series level of diffusible hydrogen and conform to the Specification for Low-Alloy Steel Electrodes; AWS A5.29
 - 4. Flux Core-Arc Welding-Self Shielding (FCAW-S): Welding electrodes for semiautomatic FCAW-S shall have a maximum H16 series level of diffusible hydrogen and conform to the Specification for Carbon Steel Electrodes; AWS A5.20
 - 5. Submerged-Arc Welding (SAW): Bare electrodes and granular flux used in submerged-arc welding shall conform to F70 or F80 AWS flux classifications of the specification for Carbon Steel Electrodes and Fluxes for submerged-arc Welding, AWS A5.17.
 - 6. Intermixing of welding processes shall not be permitted unless clearly indicated in Contractor's WPS submission. Contractor shall coordinate and submit for record all shop/field welding procedures, which overlap different welding process fusion zones
 - 7. Alternate non-prequalified welding processes shall be considered based on Contractor qualifying test result submissions of Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR)
- H. Headed Studs (shear connectors) shall be per Structural General Notes.
- I. Deformed Bar Anchors shall be as specified in Structural General Notes.
- J. Steel Castings shall conform to ASTM A27, Grade 65-35, medium strength carbon steel.

- K. Grout: Refer to General Notes.
- L. Post-installed Anchors shall be per Structural General Notes.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Work by Others: Examine all work prepared by others to receive work of this Section and report any defects affecting installation to Design Professionals. Commencement of work will be construed as complete acceptance of preparatory work by others. The Contractor alone shall be responsible for checking the dimensions and coordination of the structural steel work with other trades.
- B. Anchor Rods: At least 20 working days prior to the start of the structural steel erection, the Contractor shall ascertain by accurate survey the existing location, alignment, and elevation of the anchor rods embedded in the concrete by others. The Contractor shall immediately notify the Design Professionals of any discrepancies observed between the Contract Documents and the as-built conditions. Steel erection shall not start until corrective measures, if required, have been performed.

3.2 FABRICATION

- A. Fabricate and assemble structural steel in the shop to the greatest extent possible.
- B. Tolerances:
 - 1. Conform to the tolerances of the AISC "Code of Standard Practice," compensate for the difference between the temperature at time of fabrication and the mean temperature in service.
 - 2. Elevator shafts used for temporary hoists shall conform to the detailed requirements of the hoist manufacturer.
- C. Holes: Holes shall be provided in members to permit connections to the work of other trades or contracts, and for passage through the member of work of other trades. All holes shall be accurately drilled, cut, or punched at right angles to the surface of the metal in accordance with AISC Specifications. Thermally cut or water jet cut holes made with CNC equipment and that meet the requirements per both AISC and RCSC specifications are permitted. Thermally cut or water jet cut holes shall meet the surface roughness requirements of ASME B46.1. Burning or drifting unfair holes will not be permitted. Holes that must be enlarged shall be reamed. Drift pins will be allowed only to bring together the several parts for connection. Holes in base plates are permitted to be drilled or thermally cut. Thermally cut holes in base plates shall meet the requirements of the AISC specification section M2.2. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling operations shall be removed with a suitable tool.
- D. Camber: Provide camber as indicated on the Contract Documents. Where no camber is indicated, provide natural camber up.
- E. Cutting: Manual oxyfuel or plasma cutting processes in the shop may be used only if automatic or semi-automatic methods are not possible. If manual shop cutting is required, it shall be done only with a mechanically guided torch, except that an unguided torch may be

used where the cut is more than 1/2 inch (12mm) from the finished dimension and final removal is completed by means such as chipping or grinding to produce a gouge-free surface of quality equal to that of the base metal. At restrained joints and as indicated elsewhere, weld access holes shall be ground smooth to a bright metal finish.

- F. Cutting of Heavy Sections: Where Heavy Sections are to be joined by partial or complete joint penetration welds in tension or require slots, copes, or blocking for connections, preheating shall be required for all thermal cutting operations except at holes and slots to receive bolts. Preheat shall be sufficient to prevent cracking but in no case less than 150 degrees F (65°C). Weld access holes, weld termination holes, blocks, and copes shall be ground to a bright metal finish and a smooth radius after cutting and tested for cracks by the magnetic particle method. All cut edges shall be free of sharp notches and gouges.
- G. Anchor Rods: Rigid steel templates and anchor rods shall be furnished, labeled and shipped in sets indicating sizes and locations of columns, together with instructions for setting of anchor rods. Plate washers per Typical Details shall be provided.
- H. Bolting: Bolts shall be driven accurately into the holes without damaging the threads. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing under the head or nut.
- I. Bolts indicated as "finger tight" on the Contract Documents shall be prevented from backing off by using lock nuts, thread compound or deformed threads.
- J. Installation of High Strength Bolts:
1. Except where "snug tight" installation is specifically permitted on design Drawings, all high strength bolts shall be installed with full pretension using Turn-of-Nut Pretensioning, Twist-Off Type Tension Control Bolt Pretensioning or Direct-Tension-Indicator (DTI) Pretensioning in accordance with the "Specification for Structural Joints Using High-Strength Bolts".
 2. Comply with special washer requirements of the RCSC, such as those related to slotted and oversize holes, and tapered flanges. DTI "washers" shall not be substituted for such required washers.
 3. All high strength bolt assemblies (including Tension Control bolts and DTI's) used in pretensioned connections shall be verified in accordance with the Pre-Installation Verification section of the RCSC.
 4. Clean and re-lubricate bolts and nuts that become dry or rusty before use, except Tension Control bolts must be re-lubricated by manufacturer.
- K. Welding of Structural Steel:
1. Pre-Weld Inspection: The surface to be welded and the filler material to be used shall be subject to inspection before welding is performed.
 2. Welds indicated on the Contract Documents or the approved shop or erection drawings shall be created by electric arc welding processes that comply in all respects with the codes and specifications herein noted covering the design, fabrication, and inspection of welded structures and the qualifications of welders and supervisors. Control the heat input, weld length, weld sequence and cooling process to prevent distortion of the completed assembly.

3. Each welder's work shall be traceable.
4. Special Requirements: For High Restraint welds and welds at Heavy Sections, follow approved welding procedures for weld process, sequence, pre-heating and cooling. Use stress relieving techniques where shown in the approved procedure developed by the Contractor's Welding Consultant.
 - a) Special Procedures: Prior to the start of production welding, the contractor shall demonstrate to the Testing Agency that preheat can be maintained without relying on heat from the arc. For field welding, the contractor shall provide a shelter to protect each joint from inclement weather (rain, snow, etc.), from start until completion of the joint.
 - b) Preheat and Postheat: Preheat shall be sufficient to prevent cracking, but in no case less than required by AWS D1.1. The Contractor shall prepare a written welding sequence and distortion control plan to be included in the welding procedures submittal. Assembly sequence of adjoining parts shall balance applied induced heat from preheat and welding processes to minimize distortion and shrinkage. Complex Assemblies shall include special considerations to minimize significant shrinkage stress restraint in accordance with AWS D1.1, Annex H provisions. Under conditions of severe external shrinkage restraint, preheat temperature limitations for making welds shall be in accordance with AWS D1.1, Annex H, Table H2. Under conditions of severe external restraint, reduction of induced heat and cooling rate shall be monitored under the provisions of the Hydrogen Control/HAZ Hardness Control methods of AWS D1.1, Annex H. The preheat shall be maintained throughout the thickness of the material for a distance equal to twice the material thickness on both sides of the joint at a minimum. Where different thicknesses of steel are being joined, the greater thickness shall govern. Preheat shall be measured on the face opposite the side of the heat application. Preheat shall be applied uniformly in a manner that does not harm the surface of the material nor cause surface temperatures to exceed 1100 degrees F (600°C). Should stress relief heat treatment be required, the contractor shall submit a written procedure.
 - c) Prior to heat treatment on a production weld, prepare and treat a test sample per the Contractor's written procedure for tensile and Charpy V-notch tests in accordance with ASTM requirements.
5. Welded Joint Details:
 - a) Welding Backing: The use of weld backing shall be in accordance with AWS D1.1. Weld backing shall be removed where required by the Contract Documents or for the WPS by AWS D1.1.
 - b) Weld Tabs:
 - i. Use of Weld Tabs: Welds shall be terminated at the end of a joint in a manner that will ensure sound welds in accordance with AWS D1.1. Whenever necessary, this shall be done by use of weld tabs.
 - ii. Heavy Section Joint Weld Tab Removal and Finish: All welded tension splices in Heavy Sections shall have the weld tabs removed and ground smooth.
 - c) Weld Access Holes:

- i. Weld access holes shall meet the dimensional, surface finish, and testing requirements of AISC 360 Chapter J1.6 and AWS D1.1, except as otherwise required by the Contract Documents.
 - ii. Weld access holes are defined for this project as any hole created in order to access a weld joint, facilitate the welding process, or relieve stresses due to weld shrinkage in a web, flange, or any other element of a steel shape.
- d) Welding for moment connections shall be sequenced so as to minimize residual stress in the joint.
- e) Weld Termination Holes:
- i. Weld termination holes are defined for this project as any hole created in order to allow for weld termination or to relieve stresses due to weld shrinkage as part of the welding process.
 - ii. Re-entrant corners and/or internal radii of weld termination holes shall have a minimum radius of 1/2" or the thickness of the material divided by two, whichever is greater.
6. Deficient Welds: Welds found deficient in dimensions but not in quality may be enlarged by additional welding. Any weld found deficient in quality shall be removed by grinding or melting and the weld shall be remade.
7. Surface Roughness: Surfaces of weld access holes and weld termination holes in Heavy Sections shall be ground to a bright metal finish and inspected by Magnetic Particle Testing (MT) per the requirements of this specification.
- L. Bearing:
- 1. Bearing ends of columns shall be milled or sawn square perpendicular to axis of the column, or at slope indicated in the Contract Documents.
 - 2. Finish bearing areas of base plates per AISC M2.8.
- M. Stiffeners: Fitted stiffeners shall be ground to fit closely against flanges.
- N. Cleaning and Preparation of Steel Surfaces:
- 1. Clean all steel work in accordance with the Society for Protective Coatings (SSPC) Method specified herein that corresponds to its location and exposure. Steel work to be painted shall be painted within the same day that it is cleaned.
 - a) Interior, Not Exposed to View (above suspended ceilings, under sprayed-on fireproofing, steel to be encased in concrete): SSPC-SP-2, Hand Tool Cleaning.
 - b) Interior, Exposed in the Finished Building: SSPC-SP-6, Commercial Blast Cleaning, unless noted otherwise on the Drawings.
 - c) Exterior (exposed to weather or in unconditioned space): SSPC-SP-6, Commercial Blast Cleaning, unless noted otherwise on the Drawings.
 - d) Members to be Hot Dipped Galvanized: SSPC-SP3, Power Tool Cleaning, before galvanizing.
- O. Shop Coating:

1. Where painting is specified, paint all steel work in accordance with the Society for Protective Coatings (SSPC) Method specified herein that corresponds to its location and exposure and in accordance with manufacturer's written instructions. Paint steel work the same day that it is cleaned.
 - a) Interior, Not Exposed to View (above suspended ceilings, under sprayed-on fireproofing, steel to be encased in concrete): No Paint.
 - b) Interior, Exposed in the Finished Building: SSPC – Paint 25
 - c) Exterior (exposed to weather or in unconditioned space): SSPC – Paint 20
2. Protect finished bearing surfaces with a rust-inhibiting coating which is to be removed immediately prior to erection.
3. Do not paint:
 - a) Surfaces within six (6) inches (150mm) of field welds
 - b) Surfaces to be encased in concrete or to receive cementitious fireproofing
 - c) Contact surfaces of high-strength bolted Slip Critical connections (unless surface prep and paint has been specifically prequalified by the contractor or approved for use in this location by the SER)
 - d) Surfaces required for testing and preheat, until all testing and preheat has been performed
 - e) Finished bearing surfaces (use removable rust-inhibiting coating)
 - f) Top flange of the beam where steel deck or headed studs are to be attached
4. Paint shall be applied thoroughly and evenly to dry surfaces only when surface temperatures are above dew-point, in strict accordance with manufacturer's instructions.
5. Surfaces of exterior members which are inaccessible after assembly or erection shall receive their second coat of the approved paint, in a different shade, in the shop.
6. Hot-dip galvanize the following steel members:
 - a) All angles, steel plates and shims supporting exterior masonry or exposed to the weather, including shelf, arch and relieving angles
 - b) All connections between the above angles and steel plates and the supporting structural member, including clip angles and hardware
 - c) Any other steel members indicated as “Galvanized” on the Contract Documents.
 - d) All miscellaneous metal, angles, clips, etc. on exterior masonry walls.

3.3 ERECTION

- A. Tolerances: Erect all work plumb, square and true to lines and levels in strict accordance with the structural requirements of the building within tolerances of the AISC Code of Standard Practice, unless otherwise indicated on the Contract Documents. Compensate for the difference between the temperature at time of erection and the mean temperature in service.
- B. Bracing: Brace the frame during erection in accordance with the Contractor's erection procedure.
- C. Errors: Immediately notify the Design Professionals of any errors in shop fabrication, deformations resulting from handling and transportation, and improper erection that affects

the assembly and fitting of parts. Prepare details for corrective work and obtain approval of the method of correction. Approved corrections shall be made expeditiously at the sole expense of the Contractor.

- D. Column Base Plates: Support and align on steel shims or setting bolts. After the supported members have been plumbed and properly positioned, tighten anchor rod nuts in preparation for grouting. Cut off wedges and shims flush with edges of plates and leave in place. The use of leveling plates will not be permitted without prior written approval by the SER. Contractor proposing the use of levelling plates shall provide documentation of plumbing procedure and remediation procedure for gaps between leveling plate and column base plate for SER review.
- E. Grouting: Refer to General Notes. Grout base plates immediately after the first tier of columns are plumbed. Do not proceed with steel erection above the first tier until base plates are grouted.
- F. Bolting and Welding of Structural Steel: See Section on "Fabrication".
- G. Bearing Surface: Clean bearing surfaces and surfaces that will be in permanent contact before the members are assembled.
- H. Splices: Splices will be permitted only where indicated on the Contract Drawings or the reviewed shop drawings. Fasten splices of compression members only after surfaces are cleaned and abutting surfaces have been brought completely into contact. Fill any remaining gaps with steel shims driven into place and cut flush. Tack weld shims to each other and to members. Use runoff tabs at bevel weld splices. Cut off runoff tabs and ground smooth after weld completion.
- I. Driftpins: Driftpins may be used only to bring together the several parts, and shall not be used in such a manner as to distort or damage the metal. Correct poor matching of holes by drilling to the next larger size and using a larger size bolt. Plug welding and redrilling will not be permitted, unless a specific instance arises and is approved by the SER.
- J. Erection bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces. On non-exposed welded construction, remove erection bolts.
- K. Hammering: Hammering which may damage or distort the members will not be permitted.
- L. Do not use cutting torches in the field without the specific approval of the SER for each application. Where cutting torch use is permitted, all the requirements of the Section on "Fabrication" shall apply.
- M. Additional Material and Labor: If the Contractor furnishes additional material and labor for the purpose of erection or if the erection method requires that material be added to certain members, the required modifications shall be at the sole expense of the Contractor.
- N. Alignment: Following erection, accurately align, level, and adjust all members prior to final fastening. Conform to AISC standard tolerances unless otherwise noted in the Contract Documents.
- O. Touch-Up and Field Applied Paint: After erection, clean all damaged areas in the shop coat, exposed surfaces of bolts, bolt heads, nuts and washers and all field welds and unpainted

areas adjacent to field welds according to manufacturers recommendations and paint with the same paint used for the shop coat. Match the touch up and field applied paint color to the as-built paint color. After touch up, at exterior (exposed to the weather or in unconditioned space) steel members apply a full coat of the specified paint in a different shade than the shop applied coat.

- P. After erection, clean all damaged galvanized areas, welds and areas adjacent to welds and paint with the specified galvanizing repair paint.
- Q. Clean all steel members of mud and debris and construction residue prior to erection.
- R. Headed Studs and Deformed Bar Anchors:
 - 1. End weld headed studs and deformed bar anchors with an automatic process in accordance with section 7 of AWS D1.1.
 - 2. Areas to which studs are to be attached must be free of foreign material, such as rust, oil, grease, paint etc. When mill scale is sufficiently thick to cause difficulty in obtaining proper welds, remove by grinding or sand blasting.
 - 3. Remove ceramic ferrules from studs and work after welding.
 - 4. Replace any studs that crack or break. Only straighten studs that would foul other work or have less than 1 inch (25mm) cover in bent position.
 - 5. Straighten bent studs without heat that are part of an embed plate assembly.

3.4 CORRECTIVE MEASURES

- A. Conflicts: The Contractor shall be solely responsible for errors of detailing, fabrication, and erection of structural steel, and steel deck.
- B. Compensation for Additional Services: Should additional work by Design Professionals such as design, documentation, meetings and/or site visits be required which are necessitated by failure of the Contractor to perform the work in accordance with the Contract Documents either developing corrective actions or reviewing corrective actions developed by others, the Contractor is responsible for paying for additional work performed by the Design Professionals at their standard firm-wide billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

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Structural Substitution Request Form – to be completed by Contractor

Project:		Substitution Request #
Date:		
Requesting Contractor:		Pages Attached (including this form)

1. Description of Requested Substitution:

2. Related Drawings and Specification Sections:

3. Rationale or Benefit Anticipated:

4. Effect on Construction Schedule¹ (check one): NONE
 See Attached

5. Effect on Owner's Cost² attach data (check one): CREDIT TO OWNER
 EXTRA

6. Effect on Construction Documents³ (design work anticipated): NONE
 See Attached

7. Requesting Contractor Agrees to Pay for Design Changes (check): YES
 NO NOT APPLICABLE

8. Effect on Other Trades⁴:

9. Effect of Substitution on Manufacturer's Warranty (check): NONE
 See Attachment

Signature⁵: _____ Date: _____

Company: _____

General Contractor Signature⁵: _____ Date: _____

Notes:

- Contractor is responsible for means and methods and any problems that may arise from making the requested substitution.
- This is **NOT A CHANGE ORDER FORM**. A separate form is required to adjust costs and/or schedules.

3. Contractor is responsible for any design impacts that may arise from this substitution, including redesign efforts.
4. Contractor is responsible for effects on other trades from this substitution;
 General Contractor must review and agree effects on other trades are fairly represented in items 4-9.
5. Signature by a person having authority to legally bind his/her company to the above terms. Otherwise this request is void
6. All items in form must be completed for substitution request to be considered.

Request Review Responses (completed by Architect and/or Engineer(s)):

ACCEPTED	ACCEPTED AS NOTED	REJECTED	INSUFFICIENT DATA TO SUPPORT REQUEST	ENGINEER / ARCH / MEP SIGNATURE	DATE

Engineer/Architect Comments:

END OF SECTION 051200

SECTION 055656 – METAL TRENCH GRATES AND FRAMES

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. Products furnished, but not installed, under this Section:
 - a. Cast bronze trench grates and bronze frames.

- B. Related Sections:

- 1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts and other items cast into concrete.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include finishing materials.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
- C. Maintenance Data: For statuary conversion coating copper-alloy finish to include in maintenance manuals.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 - 2. Provide allowance for fitting at site.

1.7 COORDINATION

- B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. 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.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- 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.

2.2 BRONZE, BRASS AND COPPER ALLOYS

- A. Plate and Bars: Alloy 220 (Commercial Bronze), Alloy 230 (Red Brass) or 240 (Low Brass), complying with ASTM B36 and B248 or Alloy 280 (Muntz metal).
- B. Extruded Shapes: Alloy 314 (Commercial Bronze) or Alloy 385 (Architectural Bronze), complying with ASTM B455.
- C. Wire: Alloy 220, 230, or 240, complying with ASTM B134. Seamless Tube:
- D. Seamless Tube: Alloy 230 or 280, complying with ASTM B111 or B135, and with ASTM B251.
- E. Pipe: Alloy 220, or 230, complying with ASTM B135.
- F. Forgings: Alloy 377 (Forging Brass), complying with ASTM B124 or B283.
- G. Castings: Comply with ASTM B145 or B146, except vary the percentages of copper, zinc, tin, and lead to attain color match with other work.

2.3 FASTENERS

- A. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.4 TRENCH GRATES AND FRAMES

- A. Trench Grate Frames: Fabricate custom and adjustable frames compatible with paving assemblies as indicated on the drawings. All visible welds to be ground smooth on inside and outside edges.

1. Basis of Design: Urban Accessories, Inc., 465 East Fifteenth Street, Tacoma, WA, or COTR approved equal.
2. Model: As recommended by Manufacturer to trench grates specified herein.
3. Material: Architectural bronze, ASTM B455
4. Load Classification: Pedestrian
5. Finish: Raw Bronze
6. Width: 6-5/8" for compatibility with 6" nominal width trench grates.
7. Frame Length: As shown on the drawings and as determined through coordination with the cast in place concrete shop drawings and verified field dimensions.
8. Special Requirements: Provide customized fabrication of frame to accommodate skewed end condition as indicated on the drawings.

B. Trench Grates:

1. Basis of Design: "Terrain" by Urban Accessories, Inc., 465 East Fifteenth Street, Tacoma, WA, or COTR approved equal.
2. Material: Silicon bronze, ASTM B542, statuary grade.
3. Opening Size: No openings greater than 1/4" in conformance with ADA Accessibility Guidelines.
4. Open Area: 23.4 square inches open area per 18-inch length of grate.
5. Finish: Raw
6. Thickness: 3/4" thick at edge
7. Width: 6-inches
8. Length: Furnish grates in custom lengths for equal length segments across overall maximum length of trench. Provide a fully finished and shaped end cut on end grate section to fit shape as indicated on the drawings.

2.5 FABRICATION

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- 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.

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. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of units that are for bolted or screwed field connections.

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

END OF SECTION 055656

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SECTION 06 1083 - MISCELLANEOUS EXTERIOR ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Documents are complementary. Drawings and contract clauses of the Construction Contract, including referenced Federal Acquisition Regulation (FAR) and Division-01 Specifications Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Preservative treated wood sleepers, blocking, nailers and grounds.
- B. Related Requirements:
 - 2. Division 32 Section "Custom Fabricated Pedestrian Boardwalk System".

1.3 DEFINITIONS

- A. Dimension Lumber: Lumber of two (2) inches nominal or greater but less than five (5) inches nominal in least dimension.

1.4 SUBMITTALS

- A. Product Data and SDS: For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. General: All lumber products to be fire-retardant-treated, unless otherwise noted.
- B. Lumber: U.S. Department of Commerce, National Institute of Standards and Technology (DOC) Standard PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the 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.

2.2 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including blocking, nailers and grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with nineteen (19) percent maximum moisture content of any species.
- C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.3 PRESERVATIVE TREATMENT

- A. Pressure treat boards and dimension lumber with waterborne preservative according to AWP A U1; Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
- B. Preservative Chemicals: Acceptable to authorities having jurisdiction.
 1. Do not use chemicals containing arsenic or chromium.
- C. Use process for dimension lumber that includes water-repellent treatment.
- D. Application: Treat all wood unless otherwise indicated.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture.
 1. For pressure-preservative-treated wood, use stainless-steel fasteners.
- B. Nails, Brads, and Staples: American Society for Testing and Materials International (ASTM) Standard F 1667.
- C. Power-Driven Fasteners: Use of power driven fasteners not permitted in the Gallery.
- D. Wood Screws: American Society of Mechanical Engineers (ASME) Standard B18.2.1, ASME B18.6.1, or ICC-#S AC233
- E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1.

- G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry assemblies and equal to four (4) times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with American Forest & Paper Association's (AF&PA) "Details for Conventional Wood Frame Construction," 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 will 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. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in International Code Council's (ICC) International Building Code (IBC).

3.2 WOOD GROUND, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

END OF SECTION 06 1083

SECTION 13 2423.26 – CUSTOM FABRICATED ENGINEERED TICKET BOOTH

PART 1 -GENERAL

1.1 SECTION INCLUDES

- A.** This Section specifies all requirements necessary to furnish and install a prefabricated portable aluminum building(s) including, but not limited to the following:
1. Frameworks and surface panels with decorative trim.
 2. Metal framed windows with integrated intercom device.
 3. Doors, frames and hardware.
 4. Standing seam metal roofing.
 5. Interior plastic laminate clad wood countertop.
 6. Exterior solid surface transaction counter with integrated pass-through tray.
 7. Resilient flooring and base.
 8. Signage.
 9. Hold down clips.
 10. Rodent deterrence products.

1.2 RELATED SECTIONS

- A.** This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced prefabricated building
1. Electrical service supply and connection.
 2. Site/Foundation work.
 3. Unloading, placement, installation and anchoring.

1.3 REFERENCES

- A.** Refer to Manufacturer's published literature for technical data, design requirements and additional information.

1.4 SUBMITTALS

- A.** Product Data and SDS: For all materials, products, coatings and adhesives specified herein.
- B.** Qualification Data: For qualified professional engineer.
- C.** Delegated-Design Submittal: Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- D.** Shop Drawings: Show fabrication and installation details for all components of the booth construction, exterior trims, interior counters and signage. Include plans, elevations, sections, and details of metal fabrications, connecting components, and their connections. Show footing, supports, anchorage and accessory items.
- E.** Finish Samples: Provide samples of each interior finish specified herein.
- F.** Signage Samples:
 - 1.** Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for all exposed materials as indicated on the Drawings.
 - 2.** Samples for Verification - Dimensional Characters: Full-size Samples of each type of dimensional character (letter, number, and graphic element).
- G.** Welding certificate and continuity logs.

1.5 QUALITY ASSURANCE

- A.** Manufacturer:
 - 3.** Structures shall be the product of a manufacturer with a minimum of 10 years-documented experience in the design and fabrication of portable aluminum buildings.
 - 4.** Electrical devices factory installed within the prefabricated building shall be UL listed. Factory installed wiring system shall bear UL Classification insignia certifying compliance with the National Electrical Code, 2000 edition.
 - 5.** Design Loads: 30 lbs/ft² live load, 20 lbs/ft² wind load, 40 lbs/ft² floor load.

1.6 PERFORMANCE REQUIREMENTS

- A.** Delegated Design: Design supports and framework for booth roof, wall, and floor structures, structural anchorages to the foundation, and other system elements as identified by the booth fabricator, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B.** Structural Performance: Booth shall withstand the effects of loads and stresses within limits and under conditions as specified in the following:
 - 1.** Applicable Codes and Standards:
 - a.** 2024 International Building Code.

1.6 WARRANTY

- A.** Provide warranty against defects and workmanship for a period of one (1) year from date of original shipment.

SECTION 2 PRODUCTS

2.1 MANUFACTURER

- A.** Basis of Design: The design for the Fabricated Engineered Ticket Booth products is based upon the custom capabilities available from B.I.G. Enterprises, Inc., South El Monte, CA.
- B.** Subject to compliance with requirements indicated on the drawings and specified herein, provide product systems from the named manufacturer, or comparable system by the following:
 - 1. Par-Kut International, Inc., Harrison Township, MI.
 - 2. Mardan Fabrication, Inc. Harrison Township, MI.
 - 3. Little Buildings, Inc. Romeo, MI.
 - 4. Another manufacturer acceptable to COTR.

2.2 CUSTOM FABRICATED ENGINEERED TICKET BOOTH DESCRIPTION

- A.** Structural members to be extruded aluminum angles, channels, and tee sections of structural alloy 6063-T5 alloy. Base to be 4" x 3 x 3/16" angle (4" structural channel used on buildings larger than 8' x 12', and two piece buildings); corner posts to be 3" x 3" x 3/8" grooved angle; grooved intermediate tees to be 3" x 2 1/8" x 3/8"; top angle to be 2 1/2" x 2 1/2" x 3/16".
- B.** All structural components to be certified welded at all intersections to create a unitized framework. No rivets, bolts or other fasteners shall be used in joining structural components.
- C.** Finish – Framework:
 - 5. Mill-finished aluminum
 - a.** Provide painted exterior framework in colors specified herein.
- D.** Wall and Ceiling Panels:
 - 1. Wall panels shall be 1/2" Medex™ laminated on both sides with .030" FRP (fiberglass reinforced plastic). Panels shall be attached to the structural members with fasteners not exposed on the building exterior. Ceiling panels shall be minimum 5/8" 0.035 Smooth White Fiberglass reinforced Plastic faced plywood panels.
 - a.** Provide R-10 wall and ceiling insulation.
 - 2. Finish exterior with the manufacturer's standard coating system using custom colors to match the following:
 - a.** Trim Color: Match Benjamin Moore BM 1519 Smoke blush
 - b.** Field Color; Match Benjamin Moore BM 1233 Cedar Ridge

E. Flooring:

1. Floor structure to consist of Gray ½” low skid HDPE laminated OSB Panels and one layer of 5/8” plywood underlayment as the core with a vapor barrier on the exterior surface.
 - a. Provide R-10 floor insulation.
 - b. Provide access panels through subflooring at locations of anchorages to structural slab.
 - c. Floor Finishes:
 - i. Flooring: Provide Polyester Composition Floor Tile equivalent to “Migrations” BBT manufactured by Armstrong Flooring, Inc., Mountville, PA, in color as selected by the COTR from the manufacturer’s standard colors.
 - ii. Rubber Base: Provide adhered rubber base equivalent to Baseworks® Thermoset Rubber, Type TS, manufactured by Johnsonite – Tarkett, Solon, OH, 4” tall, in color selected by the COTR from the manufacturer’s standard colors.
 - iii. Adhesives: use adhesives as recommended by the floor tile and base manufacturers.

F. Doors:

2. Swing doors to be of 3068 20-gauge steel, 1 ¾” thick with threshold and 2’ x 2’ window with minimum ¼” clear tempered safety glass. Hardware to include: 1 ½ pair of 4 ½” x 4 ½” butt hinges; commercial quality, lever lockset; spring closer and continuous vinyl gasket on door frame.
 - a. Lock cylinders shall be interchangeable core type with removable cores as manufactured by Medeco Security, Inc. Permanent cores will be Smithsonian-furnished and installed.
 - b. Equip door with Xcluder® Low-Profile Pest Control Door Sweep as manufactured by Global Material Technologies, Inc., Buffalo Grove, IL.

G. Windows, Glazing and Intercom:

1. Windows shall have aluminum frames and inserts and to be industrial quality. Window types, sizes and configuration as indicated on the drawings.
2. Windows to be ½” tinted insulated tempered safety glass.
3. Window unit at transaction counter shall be equipped with the following:
 - a. Digital Communicator: Provide a battery powered 2-way electronic communication device equivalent to Model TTU®-1DX-L manufactured by Norcon Communications, inc., Indwood, NY.
 - b. Transaction Counter: Provide an interior/exterior transaction counter with integrated pass-thru tray Model # TE-DT-FL-12 manufactured by Armortex, Schertz, TX, as indicated on the drawings.
 - c. Transaction counter shall be finished with exterior grade solid surfacing equivalent to “Technique – Outdoor Spaces - Corian” manufactured by

DuPont in color as selected by the COTR from the manufacturer's full range of available colors

H. Interior Desk/Counter:

1. Furnish 25" deep, full-width countertop, per plans, at height as indicated on the drawings, and finished with high pressure laminate (HPL) in color as selected by the COTR.
2. Core construction shall be exterior grade plywood.

I. Electrical:

1. Electrical service to include a single-phase 150-amp capacity load center, with 70-amp main and three circuit breakers; fluorescent lighting; 110-volt 20-amp duplex outlets; 220-volt 20-amp single outlet and 20 amp switches as shown on drawings. All conduit and wiring shall be surface mounted and installed in compliance with the National Electrical Code. Conduit is 1/2" emt cable and wire is #14. All electrical components shall bear the UL label.
2. Furnish 115v duplex outlets in quantity indicated on the drawings
3. Lights to be LED type fixture with diffusing lens.
4. HVAC – Provide a 12,000 BTU 23.1 SEER wall-mounted ductless mini-split air conditioner (208-230V) comparable to Model MY-GL12NA by Mitsubishi. Provide refrigerant line set for remote location of condenser unit as indicated on the drawings.

J. Exterior Roof, Gutters and Downspouts

1. Factory installed integral roof to consist of two layers 5/8" plywood with vapor barrier on the exterior surface. Roofs to include aluminum gutters around the entire perimeter.
 - a. Provide "K-D" exterior waterproof roof shipped for assembly and installation on site by others. Decking to be standing seam formed, pre-finished aluminum in custom color as selected by the COTR, nominal 12" wide panel, .028" thick.
 - b. Provide overhangs as indicated on the drawings with Roofs with reinforcing angles as determined by the Fabricator's engineer. Perimeter to be extruded aluminum fascia and gutter trim.
 - c. Include multiple downspouts as indicated on the drawings. One downspout shall conduct stormwater from perimeter gutters to drainage trench and transition to storm piping. And additional "false" downspout shall be provided to simulate a functioning downspout and to utilized for concealing the line set connecting the indoor and outdoor HVAC equipment.

K. Signage

1. Letterforms: Provide 5-inch tall powder coated aluminum "Fabricated Dimensional Letters" as manufactured by Steel Art Architectural Signage, Norwood, MA in color as selected by the COTR, or comparable product acceptable to the COTR.
2. Pictograms: Provide custom powder coated aluminum "Fabricated Dimensional" pictogram(s) as indicated in the drawings as manufactured by Steel Art Architectural Signage, Norwood, MA in color as selected by the COTR, or comparable product acceptable to the COTR.

L. Pest Control Accessories

1. At drainage openings to the under-booth space at the structural slab depression, provide rodent proof screens fitted to the drainage openings using 1/4" Mesh T304 Welded Stainless 0.032" Wire Diameter rat control mesh as manufactured by TWP, Inc., Berkeley, CA, or COTR-approved equivalent.

PART 3 – EXECUTION

3.1 INSTALLATION - GENERAL

- A. All preparatory work and installation work shall be performed by site-contractor and shall be performed in accordance with local and/or state codes.
- B. Delivery to Site: Coordinate with Smithsonian and National Park Service to arrange for vehicle access and protection of grounds between location of offloading and final location of booth. Use cranes or loading equipment recommended by manufacturer for proper handling and movement of the booth.
- C. Structural Coordination: Coordinate with site installer for final dimensions of slab depression and locations of anchor bolts.
- D. Securing to In-Place Construction: Provide anchorage devices and fasteners at locations where Booth is to be secured to in-place construction. Provide threaded anchor bolts for use with cast-in-place concrete.
- E. Electrical: Coordinate with the site installer for exact locations of electrical infrastructure entrance to interior of booth. Make final electrical connections and clean the work area.

3.2 INSTALLING COUNTERTOPS

- A. General: Anchor securely by screwing through corner blocks provided at walls or other supports into underside of countertop.
 1. Install countertops with no more than 1/8 inch in ninety-six (96) inch sag, bow, or other variation from a straight line.

3.3 FLOORING AND BASE INSTALLATION

- A. Floor Tile:
 1. Comply with manufacturer's written instructions for installing floor tile.
 2. Lay out floor tiles from center marks established with principal walls so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 3. Lay tiles square with room axis unless indicated in the drawings.
 4. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

5. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- B.** Rubber Base: Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
1. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
 2. Do not stretch resilient base during installation.

3.3 SIGNAGE

- A.** Dimensional Letterforms and Pictograms: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
1. Retain one or both subparagraphs below, or insert others. Provide details on Drawings. If only one mounting type is required, incorporate method into paragraph above.
 2. Flush Mounting: Mount characters with backs in contact with wall surface.

3.4 ADJUSTING AND CLEANING

- A.** Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B.** Clean, lubricate, and adjust hardware.
- C.** Clean exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 13 4223.26

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.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. NETA Certifications of individuals performing and supervising tests.
- C. Documentation of current calibrations and certifications of all testing equipment.

1.5 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.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CERRO WIRE, LLC. Service Wire Co.
 - 2. General Cable Technologies Corporation.
 - 3. Southwire Incorporated.
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-THWN-2.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Power Systems, Inc.
 - 2. Ideal Industries, Inc.
 - 3. 3M; Electrical Markets Division.
 - 4. Tyco Electronics.
 - 5. Thomas & Betts Corporation.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- 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. Comply with NFPA 70, "National Electrical Code."

PART 3 - EXECUTION

3.1 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.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN-2, single conductors in raceway.
- C. Feeders Concealed below Slabs-on-Grade, and Underground: Type THHN-THWN-2, single conductors in raceway.

- D. Branch Circuits Concealed below Slabs-on-Grade, and Underground: Type THHN-THWN-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- B. 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.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Section 26 0529 "Hangers and Supports for Electrical Systems."

3.4 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.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 0553 "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.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 8413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. 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.
 - 4. Attach a label or tag to each tested component, indicating satisfactory completion of tests.
 - 5. Cables and conductors will be considered defective if they do not pass tests and inspections. Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

3.9 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared, labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING 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 grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. NETA Certifications of individuals performing and supervising tests.
- B. Documentation of current calibrations and certifications of all testing equipment.

1.5 QUALITY ASSURANCE

- 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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- 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. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (2 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (2 mm) thick.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

3.2 EQUIPMENT GROUNDING

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Install insulated equipment grounding conductors with all feeders and branch circuits.
- C. 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. Metal-clad cable runs.

3.3 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.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
- C. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- D. Prepare test and inspection reports.
- E. 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. Panelboards Serving Electronic Equipment: 1 ohm(s).
 - 3. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.5 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared, labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 260526

SECTION 260529 - 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. Section Includes:
 - 1. Hangers and supports for electrical equipment and systems.

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 the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - c. Trapeze hangers.
 - d. Clamps.
 - e. Turnbuckles.
 - f. Sockets.
 - g. Eye nuts.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation, A Member of the ABB Group.
 - e. Unistrut; an Atkore International company.

2. Material: Galvanized steel.
 3. Channel Width: 1-5/8 inches (41mm).
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored 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 made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Cooper B-Line, Inc.; a division of Cooper Industries.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are 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 unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6mm) in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other 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 two-bolt conduit clamps.

3.2 SUPPORT 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, EMTs and RMCs may be supported by openings through structure members, according to 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 (91kg).
- 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 New Concrete: Bolt to concrete inserts.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. To Existing Concrete: Expansion anchor fasteners.
 - 4. 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 (102 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) (102mm) thick.
 - 5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.

7. 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.4 WARRANTY

A. During the warranty period, the GC shall report all parts replaced/repared, labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

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. Metal wireways and auxiliary gutters.
 - 3. Surface raceways.
 - 4. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 2. Anamet Electrical, Inc.
 - 3. Electri-Flex Company.
 - 4. O-Z/Gedney; a brand of EGS Electrical Group.
 - 5. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.

- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- 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: Set Screw.
 - 3. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 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 WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman; a Pentair company.
 - 3. Mono-Systems, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. 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.
- C. 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.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman; a Pentair company.
 - 2. RACO; a Hubbell Company.
 - 3. Spring City Electrical Manufacturing Company.
 - 4. Thomas & Betts Corporation.

5. Wiremold / Legrand.
- 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, aluminum, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg) (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) (23 kg) shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square (2581 mm square) by 2-1/8 inches (54mm) deep (100 mm square by 60 mm deep).
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. 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.

PART 3 - 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.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- 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 (21-mm) (19mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use set-screw 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. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

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 NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.

- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. 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 (300 mm) (305mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls and ceilings, unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) (305mm) of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. No conduits shall be run in concrete slab unless specifically indicated on the electrical drawings.
 - 2. Aluminum conduit is not permitted to be embedded in concrete slabs.
 - 3. When conduits are allowed embedded in concrete slabs the following apply:
 - a. Conduits in concrete slabs must be spaced such that the distance between conduits, centerline to centerline, is a minimum of three times the outside diameter of the largest conduit.
 - b. No conduit may be placed in the concrete slab which has an outside diameter larger than one-third the total slab thickness.
 - c. Conduit shall be placed in the middle one-third of the slab thickness.
 - d. Conduits which cross one another in the concrete slab shall not consume a total space at the point of crossover that is greater than one-third the total slab thickness.
 - e. Conduit embedded in slabs shall not pass through cages.
 - 4. When conduit is to be placed in the slab, the Contractor must advise the Structural Engineer of the number of conduits to be placed and indicate proposed method of installation for the conduits. No conduit shall be placed without the Structural Engineer's approval.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT or GRC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. 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.
- L. 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 (35-mm) (32 mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) (38 mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

- N. 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.
- O. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) (51 mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) (91 kg) tensile strength. Leave at least 12 inches (300 mm) (305 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- Q. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch (50-mm) (51 mm) radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) (1219 mm) 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.
- R. 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.
- S. 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.
- T. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) (38 deg C) and that has straight-run length that exceeds 100 feet (30 m) (30 m).
 - 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 deg F (70 deg C) (52 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) (68 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) (52 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) (57 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot (.001981 mm per m) of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) (deg C) 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.
- U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) (1829 mm) of flexible conduit for recessed and semirecessed 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.
- V. 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.
- W. 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.
- X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- Y. Locate boxes so that cover or plate will not span different building finishes.
- Z. 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.
- AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit.
2. Install backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) (305 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

- a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (76 mm) of concrete for a minimum of 12 inches (300 mm) (305 mm) on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) (1524 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS 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 and fittings, including GRC.
 - 2. Rigid nonmetallic duct.
 - 3. Duct accessories.

1.3 DEFINITIONS

- A. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- B. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- C. GRC: Galvanized rigid (steel) conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including spacers and miscellaneous components.
 - 2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Include accessories for handholes.
 - 4. Include underground-line warning tape.
- B. Shop Drawings:
 - 1. Pre-castor Factory-Fabricated: Underground Utility Structures
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include frame and cover design, and manhole chimneys.

- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons and sumps.
- f. Include ladder details
- g. Include joint details

1.5 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Field quality-control reports.

1.6 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CANTEX INC.
 - 2. CertainTeed Corporation.
 - 3. Condux International, Inc.
 - 4. Electri-Flex Company.
 - 5. Lamson & Sessions.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 26 0553 "Identification for Electrical Systems."

END OF SECTION 260543

SECTION 260553 - IDENTIFICATION 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. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels, including arc-flash warning labels.
 - 8. Miscellaneous identification products.

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 electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70, "National Electrical Code."
- B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- C. Comply with ANSI Z535.4 for safety signs and labels.
- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (49 deg C), ambient; 180 deg F (100 deg C) (82 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

B. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

C. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels for Raceways and Cables Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceways they identify, and that stay in place by gripping action.

C. Self-Adhesive Labels:

1. Preprinted, 3-mil- (0.08-mm-) thick, polyester flexible label with acrylic pressure-sensitive adhesive.
 - a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the raceway diameter, such that the clear shield overlaps the entire printed legend.
2. Polyester, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 - a. Nominal Size: 3.5-by-5-inch (76-by-127-mm) (89 mm-by-127 mm).
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 BANDS AND TUBES:

- A. Snap-Around, Color-Coding Bands for Raceways and Cables: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) (51 mm) long, with diameters sized to suit diameters of raceways or cables they identify, and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around cables they identify. Full shrink recovery occurs at a maximum of 200 deg F (93 deg C) (93 deg C). Comply with UL 224.

2.5 TAPES AND STENCILS:

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) (25 to 51 mm) wide; compounded for outdoor use.
- C. Tape and Stencil for Raceways Carrying Circuits 600 V or Less: 4-inch- (100-mm-) (102 mm) wide black stripes on 10-inch (250-mm) (254 mm) centers placed diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) (305 mm) wide. Stop stripes at legends.
- D. Floor Marking Tape: 2-inch- (50-mm-) (51 mm) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape
 - 1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - 3. Tag: Type I:
 - a. Pigmented polyolefin, bright colored, compounded for direct-burial service.
 - b. Width: 3 inches (75 mm) (76 mm).
 - c. Thickness: 4 mils (0.1 mm).
 - d. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m) (8 kg/9 sq. m).

- e. Tensile according to ASTM D 882: 30 lbf (133.4 N) (89 N) and 2500 psi (17.2 MPa) (17 MPa).
 - 4. Tag: Type II:
 - a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, compounded for direct-burial service.
 - b. Width: 3 inches (75-mm) (76 mm).
 - c. Thickness: 12 mils (0.3 mm).
 - d. Weight: 36.1 lb/1000 sq. ft. (17.6 kg/100 sq. m) (16 kg/9 sq. m).
 - e. Tensile according to ASTM D 882: 400 lbf (1780 N) (1779 N) and 11,500 psi (79.2 MPa) (79 MPa).
 - 5. Tag: Type ID:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, compounded for direct-burial service.
 - b. Width: 3 inches (75 mm) (76 mm).
 - c. Overall Thickness: 5 mils (0.125 mm).
 - d. Foil Core Thickness: 0.35 mil (0.00889 mm).
 - e. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m) (13 kg/9 sq. m).
 - f. Tensile according to ASTM D 882: 70 lbf (311.3 N) (311 N) and 4600 psi (31.7 MPa) (32 MPa).
 - 6. Tag: Type IID:
 - a. 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, compounded for direct-burial service.
 - b. Width: 3 inches (75-mm) (76 mm).
 - c. Overall Thickness: 8 mils (0.2 mm).
 - d. Foil Core Thickness: 0.35 mil (0.00889 mm).
 - e. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m) (15 kg/9 sq. m).
 - f. Tensile according to ASTM D 882: 300 lbf (1334 N) (1334 N) and 12,500 psi (86.1 MPa) (86 MPa).
 - F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm) (25 mm).
- 2.6 TAGS
- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm) (51 by 51 by 1.27 mm), with stamped legend, punched for use with self-locking cable tie fastener.
 - B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch (0.5 mm) thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-On Tags:

1. Polyester Tags: 0.015 inch (0.4 mm) thick, with corrosion-resistant grommet and cable tie for attachment to raceway, conductor, or cable.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6 mm) grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches (180 by 250 mm) (178 by 254 mm).

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch (1-mm) (1 mm) galvanized-steel backing and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) (6 mm) grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches (250 by 360 mm) (254 by 356 mm).

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. inches (129 sq. cm) (12,903 sq. mm), minimum 1/16 inch- (1.6-mm)-(2 mm) thick.
 - b. For signs larger than 20 sq. inches (129 sq. cm) (12,903 sq. mm), 1/8 inch (3.2 mm) (3 mm) thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 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) (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa) (83 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C) (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) (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C) (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa) (83 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C) (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) (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C) (23 deg C) according to ASTM D 638: 7000 psi (48.2 MPa) (48 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) (mins 40 to plus 85 deg C).
 - 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

- B. Install identifying devices before installing acoustical ceilings and similar concealment.

- C. Verify identity of each item before installing identification products.

- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. 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.
- H. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.
- I. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- J. 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) (15 m) maximum intervals in straight runs, and at 25-foot (7.6-m) (8 m) maximum intervals in congested areas.
- K. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) (152 to 203 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) (406 mm) overall.

3.3 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch (102 mm)- (100-mm-) wide black stripes on 10-inch (250-mm) (254 mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) (305 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch (76 mm)- (75-mm-)high black letters on 20-inch (500-mm) (508 mm) centers. Stop stripes at legends. Apply stripes to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) (305 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, More Than 600 V: Self-adhesive vinyl labels. Install labels at 30-foot (10-m) (9 m) maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) (3 m) maximum intervals.

- D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
- E. 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 service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) (152 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.
- F. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- G. Install instructional sign, including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- H. 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 or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive, self-laminating polyester labels with the conductor designation.
- J. Conductors To Be Extended in the Future: Attach write-on tags to conductors and list source.

- K. 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.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- L. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
1. Install underground-line warning tape for direct-buried cables and cables in raceways.
- M. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- O. Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.
1. Comply with NFPA 70E and ANSI Z535.4.
 2. Comply with Section 26 0574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
- P. 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.
- Q. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch (10 mm)- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- R. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. 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 unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2-inch (13 mm)- (13-mm-) high letters on 1-1/2 (13 mm)-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) (51 mm) high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless labels are provided with self-adhesive means of attachment, fasten them 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 in the form of a engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Emergency system boxes and enclosures.
- h. Enclosed switches.
- i. Enclosed circuit breakers.
- j. Enclosed controllers.
- k. Variable-speed controllers.
- l. Push-button stations.
- m. Power-transfer equipment.
- n. Contactors.
- o. Remote-controlled switches, dimmer modules, and control devices.
- p. Power-generating units.
- q. Monitoring and control equipment.
- r. UPS equipment.

END OF SECTION 260553

SECTION 260573.13 - SHORT-CIRCUIT STUDIES

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Short-circuit study input data, including completed computer program input data sheets.
 - 2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
 - b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Short-Circuit Study Specialist.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
 - 1. ESA Inc.
 - 2. Operation Technology, Inc.
 - 3. Power Analytics, Corporation.
 - 4. SKM System Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, and panelboard designations.

- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "3.1 EXAMINATION."
- G. Short-Circuit Study Output:
 - 1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 - 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 - 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.
 - 1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
 - 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

- B. Gather and tabulate all of the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Calculate or obtain available fault current at point of connection to existing system.
 - 3. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 - 4. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the point of connection to existing building, extending down to the system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Low-voltage switchgear.
 - 4. Control panels.
 - 5. Standby generators and automatic transfer switches.
 - 6. Branch circuit panelboards.
 - 7. Disconnect switches.

3.3 ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

END OF SECTION 260573.13

SECTION 260573.16 - COORDINATION STUDIES

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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and equipment evaluation reports.
 - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01 0000 "Operation and Maintenance Data," include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 0573.13 " Short-Circuit Studies."
- F. Protective Device Coordination Study:
1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.

- 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
- b. Circuit Breakers:
- 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
- c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each panelboard.
 5. Provide adequate time margins between device characteristics such that selective operation is achieved.
 6. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.

- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Switchgear.
 - 3. Low-voltage switchgear.
 - 4. Standby generators and automatic transfer switches.
 - 5. Branch circuit panelboards.
- M. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
 - 1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
 - 2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
 - 3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate all of the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Calculate or obtain available fault current at point of connection to existing system.
 3. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 4. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 5. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Time-current-characteristic curves of devices indicated to be coordinated.
 - c. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - d. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - e. Panelboards, switchboards, ampacity, and SCCR in amperes rms symmetrical.
 - f. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.5 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

END OF SECTION 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from CO/TR for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Arc-Flash Study Specialist.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: In addition to items specified in Section 01 0000 "Operation and Maintenance Data," provide maintenance procedures for use by COTR's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
 - 1. ESA Inc.
 - 2. Operation Technology, Inc.
 - 3. Power Analytics, Corporation.
 - 4. SKM Systems Analysis, Inc.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.

- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 0573.13 " Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 0573.16 " Coordination Studies."
- G. Arc-Flash Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Working distance.
 - 6. Incident energy.
 - 7. Hazard risk category.
 - 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 26 0553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) (89-by-127 mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Flash protection boundary.
 - 4. Hazard risk category.
 - 5. Incident energy.
 - 6. Working distance.
 - 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies:
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 0573.13 "Short-Circuit Studies."
 - 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 0573.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of COTR.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate all of the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Calculate or obtain available fault current at point of connection to existing system.
 - 3. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

4. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
 1. Low-voltage switchboard.
 2. Switchgear.
 3. Medium-voltage switch.
 4. Control panel.

3.5 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

- A. Engage the Arc-Flash Study Specialist to train COTR's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260573.19

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.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. MCCB: Molded-case circuit breaker.
- C. SPD: Surge protective device.
- D. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. 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.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of NRTL listing for SPD as installed in panelboard.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include wiring diagrams for power, signal, and control wiring.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 0000 "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 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 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.

1.9 FIELD 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 (minus 5 deg C) to 104 deg F (minus 5 deg C to plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).

- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).

- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by COTR or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify COTR no fewer than two days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without COTR's written permission.
 - 3. Comply with NFPA 70E, "Standard for Electrical Safety in the Workplace."

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

- A. 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.
- 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. Comply with NEMA PB 1, "Panelboards."
- D. Comply with NFPA 70, "National Electrical Code."
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: UL 50E, Type 1.
 - b. Outdoor Locations: UL 50E, Type 3R.
 - c. Wash-Down Areas: UL 50E, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: UL 50E, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.
 - 2. Height: 84 inches (2.13 m) (2134 mm) maximum.

3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 5. Finishes:
 - a. Panels and Trim: 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.
- F. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Bus shall be fully rated the entire length.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
- H. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Secor, Eaton Corporation.
 - 2. ABB-GE Electrification Products.
 - 3. Siemens Energy.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Mains: Circuit breaker, or lugs only, as scheduled.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers and plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers and plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by Siemens Energy.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Subfeed Circuit Breakers: Vertically mounted.
 - 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.

2.4 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- 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. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- C. Install panelboards and accessories according to NECA 407.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- E. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box.

- G. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.
- H. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
- I. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- J. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- K. Install filler plates in unused spaces.
- L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 0553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate COTR's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 26 0553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. 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.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. 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.

D. Panelboards will be considered defective if they do not pass tests and inspections. Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. 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.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 WARRANTY

A. During the warranty period, the GC shall report all parts replaced/repared, labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 262416

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. Nonfusible switches.
 - 2. 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 nameplate ratings, 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).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01 0000 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. 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. Provide in PDF electronic format.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD 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 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with NFPA 70, "National Electrical Code."

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. ABB-GE Industrial Solutions.
 - 3. Siemens Industry, Inc.
 - 4. Schneider Electric; Square D.
- B. Type HD, Heavy Duty, Three Pole, Single 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.
- C. 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches 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 with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Comply with NECA 1, "Standard Practice of Good Workmanship in Electrical Construction."

3.3 IDENTIFICATION

- A. Comply with requirements in Section 26 0553 "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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. 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.
- C. 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. 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 enclosed switch and circuit breaker. 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 enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. 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.
 - 3. Test and adjust controls, remote monitoring, and safeties.
 - 4. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
 - 5. Report results of tests and inspections in writing. Attach a label or tag to each tested component, indicating satisfactory completion of tests.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.6 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared, labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 262816

SECTION 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

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. References to industry and trade association standards and codes are minimum installation requirement standards. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified below.
- C. This Section (270500) shall be used as a base document for all of Division 27 - Communications. The following sections shall be used in conjunction with the drawings to provide a complete and fully integrated communications system.
 - 1. 27 05 28 – Pathways for Communications Systems
 - 2. 27 05 43 - Underground Ducts and Raceways for Communications Systems
 - 3. 27 05 44 - Sleeves, Slots, and Seals for Communications Pathways and Cabling
 - 4. 27 13 00 – Communications Backbone Cabling
 - 5. 27 15 00 – Communications Horizontal Cabling

1.2 SUMMARY

- A. Section Includes:
 - 1. Administrative requirements
 - 2. Related documents
 - 3. Referenced standards
 - 4. Definitions
 - 5. Manufactured products
 - 6. Delivery, storage and handling
 - 7. Submittals
 - 8. Quality assurance

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Secure all necessary licenses, permits, inspections and final system acceptance from local authority having jurisdiction.
- B. Provide all labor, material and equipment for a complete and functional system.
- C. Provide new material and equipment that conforms to the applicable standards and listed for its intended purpose by a nationally recognized testing laboratory.
- D. Have industry certified technicians on-site.

1.4 REFERENCED STANDARDS

- A. BICSI- Standard for Installing Commercial Building Telecommunications Cabling; Latest edition
- B. BICSI TDMM - Telecommunications Distribution Methods Manual; Latest edition
- C. TIA-526-7-2015, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
- D. TIA-526-14-C-2015 (OFSTP-14), Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 Edition 2, Fiber-Optic Communications Subsystem Test Procedure- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement.
- E. ANSI/TIA-568.0-D, Rev D (9/2015+Edit:12/2015), Generic Telecommunications Cabling for Customer Premises
- F. ANSI/TIA-568.1-D, Rev D (9/2015), Commercial Building Telecommunications Infrastructure Standard
- G. ANSI/TIA-568-C.2, Rev C (8/2009+A1:2016, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
- H. ANSI/TIA-568-C.3, Rev C (6/2008+A1:10/2011), Optical Fiber Cabling Components Standard.
- I. ANSI/TIA-568-C.4–2011, Broadband Coaxial Cabling and Components Standard.
- J. ANSI/TIA-569-D–2015, Telecommunications Pathways and Spaces.
- K. ANSI/TIA/EIA-598-C–2005, Optical Fiber Cable Color Coding.
- L. ANSI/TIA-606-B-2012, Administration Standard for Commercial Telecommunications Infrastructure.
- M. ANSI/TIA-607-C-2015, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- N. ANSI/TIA-1005-A–2012, Telecommunications Infrastructure Standard for Industrial Premises.
- O. ANSI/TIA-1152–A-2016, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
- P. NFPA 70- National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q. Underwriters Laboratories, Inc. (UL)
- R. ASTM International
- S. NEMA – National Electrical Manufacturers Association
- T. NECA– National Electrical Contractors Association Standards for Good Workmanship

- U. ANSI/TIA-758-B-2012, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
- V. ANSI/TIA-862-B-2016, Structured Cabling Infrastructure Standard for Intelligent Building Systems.

1.5 DEFINITIONS

- A. BICSI - Building Industry Consulting Service International
- B. COR - Contracting Officer Representative
- C. COTR - Contracting Officer Technical Representative
- D. RCDD - Registered Communications Distribution Designer

PART 2 - PRODUCTS

2.1 MANUFACTURED PRODUCTS

- A. Provide material and equipment produced by manufacturers in the United States of America that regularly and presently produce the equipment and material specified for this project and whose products have been in satisfactory use in similar service for not less than 3 years, which replacement parts are available.
- B. 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.
- C. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer. All cables, cabling hardware, and support components, shall be from a single manufacturer to insure a certified 20-Year Component Warranty.
- D. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers 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.
- E. Subject to compliance with requirements, provide products by the following manufacturers, or approved equivalent:
 - 1. Backbone Copper Cabling Solution:

- a. Belden
 - b. Commscope
2. Backbone Fiber Cabling Solution:
 - a. Belden
 - b. Commscope
 - c. Corning
 3. Horizontal Cabling Solution:
 - a. Belden
 - b. Commscope
 4. Grounding Infrastructure:
 - a. Harger
 - b. Panduit
 5. Cable/Basket Trays:
 - a. Snaketray
 - b. Chatsworth Products
 - c. Commsocpe
 6. Pathways:
 - a. Erico/Caddy
 - b. Thomas & Betts Corp.
 7. Firestopping
 - a. Wiremold Flamestopper
 - b. STI EZ Path

2.2 DELIVERY, STORAGE AND HANDLING

- 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.
 2. Damaged equipment shall be, as determined by the Owner, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 3. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal.
 4. 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 are not obvious.

2.3 SUBMITTALS

- A. Owner approval shall be obtained for all equipment and material before delivery to the job site. Submittals shall be marked to show specification reference including the section and paragraph numbers. Submit each section separately.
- B. 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.
- C. Where variations from the contract requirements are requested, the connecting work and related components shall be included.
- D. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
 - 4. Provide UL listed systems drawings for all penetrations.
 - 5. Furnish extra materials, at Contracting Officer Representative discretion, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- E. Shop and Coordination Drawings
 - 1. Provide cable administration drawings and documentation, pathway routing and sizes, pull boxes, outlet types and locations, penetrations, elevations, sections, details, attachments to other work and as-built plans.
 - 2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include elementary and interconnection wiring diagrams, cross connects, patch panels and patch cords for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
- F. Provide Seismic Qualification Certificates from manufacturer for regions within the United States that are "At Risk" for seismic activity. For pathway racks, enclosures, cabinets, equipment racks include the following:
 - 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 certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD or RCDD and Commercial Installer, Level 2.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician or Level 2 Installer, who shall be present at all times at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.
 - 4. Installer is required to obtain certification from the manufacturer of all systems and components and install them in accordance with manufacturer's instructions.

3.2 INSTALLATION

- A. Fiber, coax, and Category cables shall be neatly dressed using Velcro (Hook and loop); and be plenum rated where required. Using nylon wire ties is prohibited.
- B. Audio, speaker, and serial control cables shall be neatly dressed using Velcro (Hook and Loop) or nylon wire ties.

3.3 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION – 270500

SECTION 270528 - PATHWAYS 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.
- B. Section 270500 Common Work Results for Communications
- C. Section 270543 Underground Ducts and Raceways for Communication Systems

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metallic surface pathways.
 - 4. Nonmetallic surface pathways.
 - 5. Hooks.
 - 6. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. EMT: Electrical Metallic Tubing
- C. Flex ENT: Flexible electrical non-metallic tubing
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Boxes, enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets and underground handholes and boxes, include plans, elevations, sections, and attachment details.

1.5 INFORMATION SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved.
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- 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. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Thomas & Betts Corporation; A Member of the ABB Group.
 - 4. Or Approved Equal.
- C. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.

3. Minimum conduit size of 15mm (.75 inch) for security conduits.
 4. Minimum conduit size of 25mm (1 inch), but not less than sizes shown on the drawings for horizontal station distributions of Category X twisted-pair copper or optical fiber cabling.
 5. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - a. Exposed, not subject to severe physical damage: EMT.
 - b. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - c. Exposed and subject to severe physical damage: GRC. Example locations include, but are not limited to the following:
 - 1) Loading dock.
 - 2) Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - 3) Mechanical rooms.
 - 4) Damp or Wet Locations
 6. Minimum back box size: 4-11/16" square x 2-1/8" deep fitted with single-gang mud ring.
 7. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
 8. Install surface pathways only where indicated on Drawings.
 9. Do not install nonmetallic conduit where ambient temps exceed 120 deg F (49 deg C).
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. IMC: Comply with ANSI C80.6 and UL 1242.
- G. PVC-Coated Steel Conduit: PVC-coated GRC or IMC.
1. Comply with NEMA RN 1.
 2. PVC Coating Thickness: Minimum 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- H. EMT: Comply with ANSI C80.3 and UL 797.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Malleable iron materials or Steel to match conduit type.
 - b. Type: compression.
 3. Expansion Fittings: Comply with UL-467 with conduit matching materials rated for environmental conditions where installed, including flexible external bonding jumper.
 4. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats.
 5. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller.
 6. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.

7. Bushings: Required for all terminating conduit ends.

J. Flexible steel conduit fittings:

1. Only steel or malleable iron materials are acceptable.
2. Clamp type, with insulated throat.

K. Rigid and IMC:

1. Sealing bushings shall have galvanized malleable iron locking ring with molded neoprene sealing ring with predrilled holes to accommodate each individual conductor, stainless steel screws and washers, PVC-coated pressure discs, and factory-installed lay-in grounding conductor lugs.
2. Hub fittings shall be 2-piece, insulated throat, liquid tight type of steel or malleable construction.
3. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
4. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
5. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
6. Erickson (union type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground.
7. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

L. Liquid tight flexible metal conduit fittings:

1. Only steel or malleable iron materials are acceptable.
2. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.

M. Rigid aluminum conduit fittings:

1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
2. Locknuts and bushings: As specified for rigid steel and IMC conduit.

N. Joint Compound for IMC, GRC, or ARC: 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 WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

- B. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1, Type 3R, Type 4, Type 12, unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- C. 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.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.3 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Fiberglass polyester extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.4 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Finish: Manufacturer's standard enamel finish in color selected by Architect. Prime coated, ready for field painting.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.5 SURFACE NONMETALLIC PATHWAYS

- A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.
- B. Finish: Texture and color selected by Architect.
- C. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with TIA-569-D.

2.6 HOOKS (TELECOMMUNICATIONS USE ONLY)

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. ANSI/TIA Category 6, 6A, 7 compliant bend radius (6 x Cable OD).
- E. Galvanized steel.
- F. J or U shaped.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures:
 - 1. Provide boxes and enclosures designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes, enclosures, and cabinets installed in damp or wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked NEMA 250 Type 1 through Type 12 based on intended application use in wet locations.
 - 3. Comply with TIA-569-D.
 - 4. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 5. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) fitted with single or dual-gang reducer ring as referenced on drawings. Other box sizes also as referenced on drawings.
 - 6. Gangable (expandable) boxes are allowed.
- 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 or aluminum, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: adjustable.
 - 3. Shape: Rectangular.
 - 4. 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. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
 - 1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 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, cast aluminum with gasketed cover.
- I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, [Type 1] [Type 3R] [Type 4] [Type 12], with continuous-hinge cover with flush locking latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures:
 - a. Material: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

3.2 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: [GRC] [IMC] [RNC, Type EPC-40-PVC] [RNC, Type EPC-80-PVC].
 - 2. Concealed Conduit, Aboveground: [GRC] [IMC] [EMT] [RNC, Type EPC-40-PVC].
 - 3. Underground Conduit: RNC, [Type EPC-40-PVC] [Type EPC-80-PVC], [direct buried] [concrete encased].

4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Indoors: Apply pathway 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: IMC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT, and innerduct.
 5. Damp or Wet Locations: IMC.
 6. Pathways for Optical-Fiber and Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
 7. Pathways for Optical-Fiber and Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway Riser-type, communications-cable pathway, EMT.
 8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, General-use, communications-cable pathway, Riser-type, communications-cable pathway, Plenum-type, communications-cable pathway, EMT.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: [3/4-inch (21-mm)] for security wiring; [1 inch (25 mm)] trade size for communications copper and for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways 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. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealants recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.3 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270544.10 "Sleeves and Sleeve Seals for Security Pathways and Cabling" for sleeves and sleeve seals for communications.
- E. Label all telecom and security conduits with separate marking bands of tape or paint every 10 feet (9000 mm). Paint junction box covers with paint manufactured by Benjamin Moore, Duron (Americana), or approved equivalent.
 - 1. Coordinate use of designated colors with Owner's enterprise standards as well as those intended for use by other Division 26 disciplines.
- F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab or below finished ceiling.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
 - 1. Conduits of 2" trade size or less shall not exceed a minimum bend radius of 6 times the conduits internal diameter.
 - 2. Conduits larger than 2" trade size shall not exceed a minimum bend radius of 10 times the conduits internal diameter.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Pathways Embedded in Slabs:

1. Run conduit larger than 1 inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10 foot (3 m) intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from nonmetallic below-grade conduit and fittings to IMC and fittings before rising above point of entry floor.
- M. Stub-ups to Above Recessed Ceilings and Conduit Terminations at Cable Trays:
1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- R. 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.
- S. Cut conduit perpendicular to the length. For conduits of 2 inch (50 mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200 lb (90 kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- U. Use nylon mule tape in all 3" or large conduits. Leave at least 12 inches (300mm) of slack at each end of each conduit, and tie-off all tapes at each end
- V. Conduit Supports:
1. Support multiple conduit runs with trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds).
 2. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T bars, angle supports, and similar items.
 3. Fasteners and Supports in Solid Masonry and Concrete:

- a. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - b. Existing Construction:
 - 1) Steel expansion anchors not less than 6mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
 - 2) Power set fasteners not less than 6mm (1/4 inch) diameter with depth of penetration not less than 75mm (3 inches).
 - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
 4. Hollow Masonry: Toggle bolts are permitted.
 5. Bolts supported only by plaster or gypsum wallboard are not acceptable.
 6. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
 7. Attachment by wood plugs, crawl plugs, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
 8. Chain, wire, or perforated straps shall not be used to support or fasten conduit.
- W. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings (Telecommunications Only).
 2. Install surface pathway with a minimum 2 inch (50-mm) radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- X. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4 Inch (21 mm) Trade Size: Install pathways in maximum lengths of 50 feet (15 m).
 2. 1 Inch (25 mm) Trade Size and Larger: Install pathways in maximum lengths of 100 feet (30 m).
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- Y. Fabric Pathways for Optical-Fiber-Cable:
1. Install per manufacturer's recommendations and guidelines.
 2. Provide textile innerduct in conduit and wire ways, and place textile innerduct within and/or suspended underneath cable trays using continuous, unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the Drawings.
 3. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.
 4. Cable Tray and Runway Installation: Cut incisions every 24 inches (61 cm) into the edge of the textile innerduct and cable wrap to one side of vertical ladder rack or horizontal ladder-type cable tray at each incision.

- Z. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway-sealing fittings according to NFPA 70.
- AA. Install devices to seal pathway 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 pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- BB. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- CC. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).
 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 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) 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 (0.06 mm per meter of length of straight run per deg C) 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 (0.0115 mm per meter of length of straight run per deg C) 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.
- DD. Hooks (Telecommunications Only, Not allowed for Security):
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods used in for other conduits, pipes, ducts, or equipment.
 3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and

- fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet (1.5 m) o.c.
 5. Provide a hook at each change in direction.
- EE. 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.
- FF. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- GG. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- HH. 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.
- II. Fasten junction and pull boxes or their supports from building structure. Do not support boxes by conduits alone.
- JJ. Set metal floor boxes level and flush with finished floor surface.
- KK. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- LL. Zip ties may not be used in any fashion for conduit support and/or cable management.

3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.

- b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
- 7. Underground-Line Warning Tape:
 - a. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway 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.
 - b. Install underground-line warning tape for direct-buried cables and cables in raceways.

3.5 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes with bottom below frost line, 30" below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544.10 "Sleeves and Sleeve Seals for Security Pathways and Cabling."

3.7 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping." Do not begin installation work until certificates of conformance or compliance, manufacturer's catalog data, and details for

fire stopping of penetrations and joint systems showing compliance with the appropriate UL Design Number are approved by the Office of Safety Health and Environmental Management Fire Protection Engineer.

3.8 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or 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 270528

SECTION 270543 - UNDERGROUND DUCTS AND RACEWAYS 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.
- B. Section 270500 Common Work Results for Communications

1.2 SUMMARY

- A. Section Includes:
 - 1. Rigid nonmetallic duct.
 - 2. Duct accessories, including rigid innerduct and fabric innerduct.
 - 3. Polymer concrete handholes and boxes with polymer concrete cover.
 - 4. Fiberglass handholes and boxes with polymer concrete cover.
 - 5. Fiberglass handholes and boxes.
 - 6. High density plastic boxes.

1.3 DEFINITIONS

- A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

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

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.
3. Include accessories for handholes, boxes, and other utility structures.
4. Include underground-line warning tape.

B. Shop Drawings:

1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, routes and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including location and duct size.
 - c. Include cover design.
 - d. Include grounding details.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C858.
- C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service as may be deemed necessary according to requirements indicated by Owner and associated project representatives:
 1. Notify Owner no fewer than two (2) days in advance of proposed interruption of communications service.
 2. Do not proceed with interruption of communications service without Owner's written permission.

- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.
- C. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 RIGID NONMETALLIC DUCTS

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Underground Plastic Utilities Duct: Type EB-20 PVC RNC, complying with NEMA TC 6 & 8, ASTM F512, and UL 651, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.
- C. Charlotte Pipe, JM Eagle, or approved equal.
- D. General Requirements for Nonmetallic Ducts and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-C and TIA-758-C.
- E. Solvents and Adhesives: As recommended by duct manufacturer.

2.2 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC 40-HDPE complying with NEMA TC 7 and UL 651A.
 - 1. United Poly Systems, WL Plastics, or approved equal
 - 2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 3. Comply with TIA-569-C and TIA-758-C.

2.3 DUCT ACCESSORIES

- A. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal color-coded pull tape and detectable tracer wire preinstalled.
 - 1. Include single unit assembly of 3-Cell product for use in 2" ducts, tied off at each end in accordance with manufacturer's instructions.

2. Utilize MaxCell MXC-series standard product MXC2003XX#### or approved equal where detectable tracer wire is not required due to it already being inherent to the portion of new/existing buried ductbank route covering the installation.
 3. Utilize MaxCell MXC-series detectable product MXD2003XX#### or approved equal where detectable tracer wire is required since it is not already inherent to the portion of new/existing buried ductbank route covering the installation.
- B. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
- C. Precision Plastics Inc., TrenchSafe, or approved equal.
- D. Underground-Line Detectable Warning Tape: Underground-line 2” polyester-encased aluminum foil laminate warning tape, printed with Fiber Optic or Telephone utility warning label. Brady B-721, Seton, or approved equal.
- 2.4 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER
- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - B. NovaLight Telecom Supply, Jensen Precast, or equivalent.
 - C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 - D. Color: Gray, Green or Neutral (Beige) based on location and placement.
 - E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
 - F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - H. Cover Legend: Molded lettering, "COMMUNICATIONS" or "COMM".
 - I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
 - K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.5 FIBERGLASS REINFORCED POLYMER (FRP) HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME RING AND COVER

- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
- B. NovaLight Telecom Supply, Jensen Precast, or equivalent.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray, Green or Neutral (Beige) based on location and placement.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS or "COMM".
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. 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.
 - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications: Type EPC-40-PVCRNC, in concrete-encased duct bank unless otherwise indicated.
- B. Duct for Communications: Type EPC-40-PVCRNC, in direct-buried duct bank unless otherwise indicated.
- C. Duct for Communications: Type EPEC-40-HDPEduct in direct-bored duct bank unless otherwise indicated.
- D. Underground Duct Crossing Paved Paths, Walks, and Roadways: Type EPC-40-PVC RNC, encased in reinforced concrete.
- E. Stub-Ups for Communications: RNC, Concrete-encased where subjected to vehicular traffic.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for Communications:
 - 1. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15, or Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.
 - 2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8, or Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
 - 3. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated.
- D. 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 Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.
- C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End-Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct slope and without forming a trap in the line.
 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch (19 mm).
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct and vary proportionately for other duct sizes.
1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator without reducing duct slope and without forming a trap in the line.
 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch (19 mm).
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- K. Innerduct: Install immediately after mandreling duct. Size and type as indicated herein. Provide three innerducts per duct.
- L. Pulling Cord: Install 200-lbf- (1000-N-m) test nylon cord in empty ducts and innerducts.
- M. Concrete-Encased Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
 2. Width: Excavate trench 12 inches (300 mm) wider than duct or duct bank on each side.
 3. Width: Excavate trench 3 inches (75 mm) wider than duct or duct bank on each side.
 4. Depth: Install top of duct and duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 5. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Minimum Space Between Duct: 3 inches (75 mm) between edge of duct and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and communications ducts.
 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers

- to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
 9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple GRC to duct with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches (100 mm) above finished floor and minimum 3 inches (75 mm) from conduit side to edge of slab.
 - c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches (100 mm) above finished floor and no less than 3 inches (75 mm) from conduit side to edge of wall.
 10. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 11. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 12. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between ducts, and 4 inches (100 mm) between power and communications duct.
 13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
 14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

N. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for duct less than 6 inches (150 mm) in nominal diameter.
 2. Install duct with a minimum of 3 inches (75 mm) between duct for like services and 6 inches (150 mm) between power and signal duct.
 3. Width: Excavate trench 12 inches (300 mm) wider than duct or duct bank on each side.
 4. Width: Excavate trench 3 inches (75 mm) wider than duct or duct bank on each side.
 5. Depth: Install top of duct or duct bank at least 36 inches (900 mm) below finished grade unless otherwise indicated.
 6. Set elevation of bottom of duct or duct bank below frost line.
 7. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 8. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
 9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow. Extend encasement minimum of 36 inches (900 mm) beyond elbow joints.
 10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple GRC to duct with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.
 - b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum of 3 inches (75 mm) of sand as a bed for duct and duct bank. Place sand to a minimum of 6 inches (150 mm) above top level of duct and duct bank.
 - b. Place minimum of 6 inches (150 mm) of engineered fill above concrete encasement of duct bank.
- O. Underground-Line Warning Tape: Bury conductive underground-line warning tape no less than 12 inches (300 mm) above all concrete-encased duct and duct bank and approximately 12 inches (300 mm) below grade. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

3.7 INSTALLATION OF HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below frost line, considered to be 30" below grade at Project site.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and aggregate pathways subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure, and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of all ducts until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of new handholes, including sump where provided.
 - 1. Remove all debris.
 - 2. Remove foreign materials.
 - 3. Ensure innerducts and pull-tapes are securely tied off at each end of each pull segment.

END OF SECTION 270543

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS 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. Section 270500 Common Work Results for Communications

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway 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. Position sleeves adjacent to vertical plywood wall. Do not obstruct wall-terminating space. Rather, utilize space positioned directly above or below plywood walls used for termination fields.

- C. 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.
- D. Extend sleeves a minimum of 1” above the floor level, 2” past wall surface.
- E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- H. Slot Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLOT SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon or Stainless steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or Stainless steel 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.

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.
- 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 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 pathway 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 (6.4 mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 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 (50 mm) 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 pathways 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 (25 mm) 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 (25 mm) annular clear space between pathway 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 pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway 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 water-stop 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 270544

SECTION 271116.10 - SECURITY CABINETS, RACKS, FRAMES, AND ENCLOSURES

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. Section 280500.10 "Common Work Results for Electronic Security".

1.2 SUMMARY

- A. Section Includes:
 - 1. 19-inch freestanding and wall-mounted equipment cabinets.
 - 2. Power strips.
 - 3. Grounding.
 - 4. Labeling.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TDMM: Telecommunications Distribution Methods Manual
- G. TGB: Telecommunications grounding bus bar.

H. TIA: Telecommunications Industry Association

I. TMGB: Telecommunications main grounding bus bar.

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 equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: A BICSI Installer 2 (Copper and Fiber, as applicable) shall perform all installation work with a BICSI Technician providing direct supervision of the installation work. Technician shall be present at all times when performing Work of this Section at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 <Insert Seismic zone>.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. UL listed.
- C. RoHS compliant.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backboards specified in Section 061000 "Rough Carpentry."
- B. Backboard Paint: Pre-painted white with fire-retardant paint. Paint all six sides with two coats of fire resistant paint. Do not paint over manufacturer's label.

2.3 NEMA 4X ENCLOSURE

- A. Acceptable Manufacturers
 - 1. Hoffman
- B. Hoffman CSD16166 or approved equivalent.
- C. Minimum Required Features and Specifications
 - 1. 16 or 14 gauge steel
 - 2. NEMA 4X rated
 - 3. Single Door, hinged
 - 4. Lock inserts
 - 5. Wall mounting brackets
- D. Additional Required Options / Parts
 - 1. CDR3P16 DIN rail mounting kit

2. Mounting channel CMC16

2.4 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Bond each enclosure to electrical panel ground.
- C. Comply with NECA/BICSI 607.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate placement of communications and security equipment enclosures with SI-OPS and SI-OCIO representatives.
 1. Coordinate internal enclosure components with SI-OPS and OCIO representatives.
 2. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 3. Record agreements reached in meetings and distribute them to other participants.
 4. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of communications equipment.

5. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in enclosure panel.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection".

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-B.
- D. Labels shall be machine printed. Type shall be 3/16 inch (5 mm) in height.

END OF SECTION 271116.10

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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. 9/125 micrometer single-mode (OS2) indoor-outdoor loose tube, optical fiber cable.
 - 2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
 - 3. Cabling identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. ICEA: Insulated Cable Engineers Association
- D. ITSIMM: Information Technology Systems Installation Methods Manual
- E. RCDD: Registered Communications Distribution Designer.
- F. TIA: Telecommunications Industry Association

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber backbone cabling system shall provide interconnections between communications rooms, main terminal space, and entrance facilities in the communications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

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

- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 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. Backbone Riser Diagram.
 - 5. Interconnects and patch panels. Show detail mounting assemblies, elevations and physical relationship between the installed components.
- C. Optical fiber cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of BICSI certified Technician or Level 2 Installer, 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
 - 2. Test optical fiber cable 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.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-3.D, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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. Communications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.2 12-STRAND MULTIMODE (OS2) PLENUM-RATED, INDOOR-OUTDOOR OPTICAL FIBER CABLE

- A. Acceptable Manufacturers
 - 1. Corning Cable Systems 012ZSP-T4101D20,
 - 2. Belden FDSL012P0, or approved equivalent.
- B. Minimum Required Features and Specifications
 - 1. Single-mode:
 - a. 9/125-micrometer, 12 fibers, nonconductive loose tube, optical fiber cable (OS2).
 - b. Max Attenuation: .4 dB/km@1310 nm; .4 dB/km@1383 nm; .3 dB/km@1550 nm.
 - 2. Standards:
 - a. Comply with TIA-492CAAB for detailed specifications.
 - b. Comply with TIA-568-3.D for performance specifications.
 - c. Comply with ICEA S-104-696 for mechanical properties.
 - 3. Jacket:
 - a. Jacket Color: Black.
 - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

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. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-3.D

B. Source Limitations: Obtain optical fiber cable hardware from single source and from single manufacturer. Provide cable hardware form same manufacturer as optic fiber cable.

C. Room and Closet Fiber Panels

1. Rack-mount Panels acceptable manufacturers (Equipment Room near-end)
 - a. Corning CCH-01U
 - b. Belden ECX-01U, or approved equivalents
2. Minimum Required Features and Specifications
 - a. One (1) rack unit high
 - b. Flush mount in 19" rack
 - c. Holds a minimum of two Connector Panels or Termination Cassettes
 - d. Lockable Front and Rear access with slide-out tray
 - e. Removable top cover
 - f. Include door locks, cable and patch cord management, strain reliefs, blank panels and labeling accessories for a complete panel installation.
3. Wall-mount Panels (Closet far-end)
 - a. Corning Single-Panel Housing, SPH-01P-CLRDR,
 - b. Belden FiberExpress, EXC-01WH Wall Mount Housing, or approved equivalent.
 - 1) Meet requirements for minimal depth and footprint mount space.
 - 2) Wall-mountable and/or DIN-rail mountable w/in equipment enclosure panel.
 - 3) Holds 1 Fiber Pigtail-Splice or Field-Terminable slack storage Cassette.
 - 4) Include DIN-rail, cable mgmt, strain relief and label accessories as required.

D. Interconnect Assemblies within Patch Panels: Modular panel assemblies housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each strand of fiber cable or subset of cable strands assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
2. Connector Components and Required Misc Accessory Parts (xx = 06 or 12 strand count and yy = 03 or 06 duplex port count)

- a. Corning Connector Adapter Panel, UPC, Duplex LC, CCH-CPxx-A9;
 - b. Corning Pigtail Splice Cassette, UPC Duplex LC, CCH-CS-xx-A9-P00RE;
 - c. Corning Slack Storage Cassette, UPC Duplex LC, CCH-CF-xx-A9;
 - d. Belden FiberExpress, Adapter Strip, UPC, Duplex LC AX101731;
 - e. Belden FiberExpress, Pigtail Splice Cassette, UPC, Duplex LC, FCSXyyLDFFP;
 - f. Belden FiberExpress, Field Terminable Cassette, UPC, Duplex LC FCSXyyLDFT;
 - g. Or manufacturer approved equivalents.
- E. Patch Cords: Factory-terminated, OS2 dual-fiber cables. Include (2) at 40 inch (1.0m) lengths and (2) at 84 inch (2.0m) lengths. Coordinate and confirm actual lengths and quantities with OCIO prior to placing product order.
1. Connector Type: Type LC duplex complying with TIA-604-10-B.
 2. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
 3. Insertion loss 0.15 dB typical.
 4. Marked to indicate transmission performance.
 - a. Corning OS2 Duplex LC to Duplex LC Cords, 040402R51200zzM (z = length).
 - b. Belden OS2 Duplex LC to Duplex LC Patch Cords, FPSLDLDzzzM (z = length)
 - c. Or manufacturer approved equivalents.
- F. Connector Assemblies:
1. Unless utilizing approved preconfigured pig-tail cassette assemblies with fusion spliced termination methods, provision mechanical female, quick-connect, simplex fixed connectors designed for termination of a single optical fiber cable.
 2. Insertion loss max not more than 0.5 dB; typical 0.2 dB.
 3. No Epoxy, No Polish.
 - a. Corning UniCam Mechanical LC Connectors, 95-200-99.
 - b. Belden Mechanical LC Connectors, AX105203-S1
 - c. Or manufacturer approved equivalents.
- G. Telecom Equipment Enclosure Panel
1. Steel gray metal box with lockable hinged solid single-door with window cover, minimally sized at 16" x 16" x 6" deep (406 mm x 406 mm x 152 mm) or larger for remote far-end equipment and associated cabling infrastructure. Include grommeted cable knockouts and DIN rails for internal component mounts.
 - a. Nvent/Hoffman CSD16166
 - b. Hammond, or approved equivalent

2.4 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

- A. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-3.D
- B. Factory pre-terminated optical fiber cable assemblies tested according to TIA-526-14-B and TIA-568-3.D
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 GROUNDING

- A. Utilize minimum 6AWG green grounding conductors and 2-hole compression lugs with paint-piercing washers to bond metallic equipment panel enclosures to nearest approved building ground within designated project carousel facility.
- B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems".

3.2 WIRING METHODS

- A. Wiring Methods: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
 - 1. Install contiguous Indoor/Outdoor plenum cable in interior and exterior locations in a homerun fashion.
 - 2. Within the existing building facilities up to the point of egress to OSP conduit paths, route the new backbone cable(s) by utilizing existing pathway supports such as cable trays and conduits up to the building's point of egress. Additionally route the new backbone fiber cable(s) in existing 1" or larger innerduct where available along the existing ISP portion of the pathway route. Where no innerduct exists, install new 1" (25 mm) or larger plenum-rated innerduct with pull-line installed.
 - 3. At the building's point of egress to OSP conduit paths, continue all cable runs in new 1.5" (38mm) or larger underground schedule-40 conduit provisioned to the destination facility.
 - 4. Only where existing low-voltage OSP conduit provisions are 2" or larger, include and install new Maxcell 3-pocket fabric innerduct in a point-to-point fashion between all respective pull-points and securely tie them off at each end. Run new backbone fiber(s) within the new innerduct segment(s).
 - 5. Coordinate with SI-OPS and SI-OCIO for final Headend Room, Rack and Patch Panel destination and the existing pathway systems to utilize in route to that point-of-origin.
 - 6. Additionally coordinate with NMAH/NHB high-voltage contractor regarding use of existing low-voltage OSP conduit between existing building point-of-entry and the T4 Manhole for all associated fiber pass-thru work.
- B. Wiring within Equipment Panel Enclosures internal to project facility: Bundle, lace, and train cables within enclosures. Connect cable conductors to terminal points with no excess and without exceeding

manufacturer's limitations on bending. Externally provide minimum 12" (300 mm) coil of cable service slack prior to entry to the equipment enclosure.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568-1.D and TIA-568-3.D
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced except for termination purposes. 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.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. 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.
 - 8. Cold-Weather Installation: Bring cable to room temperature before unreeling. Heat lamps shall not be used for heating.
 - 9. In the communications rooms, provide a 10 foot (3 m) long service loop on each end of cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 11. Terminate cable by means of pigtail fusion splicing on connecting hardware that is rack or cabinet mounted.
 - 12. Placement of Cable into Conduit Risers: Provide conduit risers as indicated on the plans. Use Kellum grips and/or other hanger devices to support the vertical drop of cable and prevent any possible kinking of the cable after installation.
 - 13. Minimum Bend Radius: For static storage, do not bend the cable at any location to less than ten times the outside diameter of the cable or as recommended by the manufacturer. During installation, the cable shall not be bent at any location to less than twenty times the outside diameter of the cable or as recommended by the manufacturer.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in communications spaces with terminating hardware and interconnection equipment.
 - 2. Do not run cable through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Installation of Cable Routed Exposed under Raised Floors (only as required):
 - 1. Install Indoor/Outdoor 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.

E. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping." Do not begin installation work until certificates of conformance or compliance, manufacturer's catalog data, and details for fire stopping of penetrations and joint systems showing compliance with the appropriate UL Design Number are approved by the Office of Safety Health and Environmental Management Fire Protection Engineer.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-C.

1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each communications 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.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for communications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables.

D. 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. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
3. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

E. 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 606-C, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect optical fiber 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-568-1.D.
2. Visually inspect cable placement, cable termination, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-3.D. 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) Test Single-mode link measurements at 1310 and 1550 nm in both directions. Use procedures specified in TIA-526-7-A.1 (OFSTP-7), Measurement of Optical Power Loss for installed Single-mode fiber cable plant.
 - 2) Multimode measurements: For OM-3,-4,-5 cable types, test at 850nm in both directions according to TIA-526-14-B, Method B, One Reference Jumper.
 - 3) Otherwise for OM-1 or OM-2 cable types based on LED (non-VCSEL) application use by Owner, test at both 850nm and 1300nm in one direction only when commissioning.
 - 4) All attenuation test results shall be less than those calculated according to equation in TIA-568-3.D for the cable type under test.
 - c. OTDR Test: Perform optical time domain reflectometer tests in the 850 to 1300 nanometers wavelength band on the fiber optic cable after it is installed. Calibrate the optical time domain reflectometer to show anomalies of zero point two (0.2) dB as a minimum. If the optical time domain reflectometer test results are unsatisfactory, replace unsatisfactory segments with a new segment of cable at no cost to the Owner. Test the new segment of cable to demonstrate acceptability. Furnish photographs of the traces to the Owner for each circuit.

B. Document data for each measurement. Print data for submittals 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 submit electronically.

C. Remove and replace cabling where test results indicate that it does not comply with specified

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Validation: Test random fiber strands at Owner/Engineer's discretion to confirm validity of test results. Contractor to perform cable testing in presence of Owner/Engineer using Contractor staff and utilizing same test equipment that was used for final acceptance testing by Contractor. Owner reserves the right to validate up to 100% of installed optical fiber.

- G. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 271300

SECTION 271300.10 - SECURITY 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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. 9/125 micrometer single-mode (OS2) indoor-outdoor loose tube, optical fiber cable.
 - 2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
 - 3. Cabling identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. ICEA: Insulated Cable Engineers Association
- D. ITSIMM: Information Technology Systems Installation Methods Manual
- E. RCDD: Registered Communications Distribution Designer.
- F. TIA: Telecommunications Industry Association

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber backbone cabling system shall provide interconnections between communications rooms, main terminal space, and entrance facilities in the communications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 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. Backbone Riser Diagram.
 - 5. Interconnects and patch panels. Show detail mounting assemblies, elevations and physical relationship between the installed components.
- C. Optical fiber cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of BICSI certified Technician or Level 2 Installer, 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable 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.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-3.D, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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. Communications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.2 6-STRAND SINGLE-MODE (OS2) PLENUM-RATED, INDOOR-OUTDOOR OPTICAL FIBER CABLE

- A. Acceptable Manufacturers
 1. Corning Cable Systems
 2. Belden
- B. Corning 006ZSP-T4101D20, Belden FDSL006P0, or approved equivalent.
- C. Minimum Required Features and Specifications
 1. Single-mode:
 - a. 9/125-micrometer, 6 fibers, nonconductive loose tube, optical fiber cable (OS2).

- b. Maximum Attenuation: 0.4 dB/km at 1310 nm; 0.3 dB/km at 1550 nm.
2. Standards:
 - a. Comply with TIA-492CAAB for detailed specifications.
 - b. Comply with TIA-568-3.D for performance specifications.
 - c. Comply with ICEA S-104-696 for mechanical properties.
3. Jacket:
 - a. Jacket Color: Black.
 - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).
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. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-3.D

B. Source Limitations: Obtain optical fiber cable hardware from single source and from single manufacturer. Provide cable hardware from same manufacturer as optic fiber cable.

C. Room and Closet Fiber Panels

1. Rack-mount Panels acceptable manufacturers (Equipment Room near-end)
 - a. Corning CCH-01U
 - b. Belden ECX-01U, or approved equivalents
2. Minimum Required Features and Specifications
 - a. One (1) rack unit high
 - b. Flush mount in 19" rack
 - c. Holds a minimum of two Connector Panels or Termination Cassettes
 - d. Lockable Front and Rear access with slide-out tray
 - e. Removable top cover
 - f. Include door locks, cable and patch cord management, strain reliefs, blank panels and labeling accessories for a complete panel installation.
3. Wall-mount Panels (Closet far-end)
 - a. Corning Single-Panel Housing, SPH-01P-CLRDR,
 - b. Belden FiberExpress, EXC-01WH Wall Mount Housing, or approved equivalent.
 - 1) Meet requirements for minimal depth and footprint mount space.
 - 2) Wall-mountable and/or DIN-rail mountable w/in equipment enclosure panel.
 - 3) Holds 1 Fiber Pigtail-Splice or Field-Terminable slack storage Cassette.
 - 4) Include DIN-rail, cable mgmt, strain relief and label accessories as required.

- D. Interconnect Assemblies within Patch Panels: Modular panel assemblies housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each strand of fiber cable or subset of cable strands assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
 2. Connector Components and Required Misc Accessory Parts (xx = 06 or 12 strand count and yy = 03 or 06 duplex port count)
 - a. Corning Connector Adapter Panel, UPC, Duplex LC, CCH-CPxx-A9;
 - b. Corning Pigtail Splice Cassette, UPC Duplex LC, CCH-CS-xx-A9-P00RE;
 - c. Corning Slack Storage Cassette, UPC Duplex LC, CCH-CF-xx-A9;
 - d. Belden FiberExpress, Adapter Strip, UPC, Duplex LC AX101731;
 - e. Belden FiberExpress, Pigtail Splice Cassette, UPC, Duplex LC, FCSXyyLDLFP;
 - f. Belden FiberExpress, Field Terminable Cassette, UPC, Duplex LC FCSXyyLDLFT;
 - g. Or manufacturer approved equivalents.
- E. Patch Cords: Factory-terminated, OS2 dual-fiber cables. Include (2) at 40 inch (1.0m) lengths and (2) at 84 inch (2.0m) lengths. Coordinate and confirm actual lengths and quantities with OCIO prior to placing product order.
1. Connector Type: Type LC duplex complying with TIA-604-10-B.
 2. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
 3. Insertion loss 0.15 dB typical.
 4. Marked to indicate transmission performance.
 - a. Corning OS2 Duplex LC to Duplex LC Cords, 040402R51200zzM (z = length).
 - b. Belden OS2 Duplex LC to Duplex LC Patch Cords, FPSLDLDLzzzzM (z = length)
 - c. Or manufacturer approved equivalents.
- F. Connector Assemblies:
1. Unless utilizing approved preconfigured pig-tail cassette assemblies with fusion spliced termination methods, provision mechanical female, quick-connect, simplex fixed connectors designed for termination of a single optical fiber cable.
 2. Insertion loss max not more than 0.5 dB; typical 0.2 dB.
 3. No Epoxy, No Polish.
 - a. Corning UniCam Mechanical LC Connectors, 95-200-99.
 - b. Belden Mechanical LC Connectors, AX105203-S1
 - c. Or manufacturer approved equivalents.
- G. Security Equipment Enclosure Panel
1. Steel gray metal box with lockable hinged solid single-door with window cover, minimally sized at 16" x 16" x 6" deep (406 mm x 406 mm x 152 mm) or larger for remote far-end equipment and associated cabling infrastructure. Include grommets cable knockouts and DIN rails for internal component mounts.
 - a. Nvent/Hoffman CSD16166
 - b. Hammond, or approved equivalent

2.4 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

- A. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-3.D
- B. Factory pre-terminated optical fiber cable assemblies tested according to TIA-526-14-B and TIA-568-3.D
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 GROUNDING

- A. Utilize minimum 6AWG green grounding conductors and 2-hole compression lugs with paint-piercing washers to bond metallic equipment panel enclosures to nearest approved building ground within designated project carousel facility.
- B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems".

3.2 WIRING METHODS

- A. Wiring Methods: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
 - 1. Install contiguous Indoor/Outdoor plenum cable in interior and exterior locations in a homerun fashion.
 - 2. Within the existing building facilities up to the point of egress to OSP conduit paths, route the new backbone cable(s) by utilizing existing pathway supports such as cable trays and conduits up to the building's point of egress. Additionally route the new backbone fiber cable(s) in existing 1" or larger innerduct where available along the existing ISP portion of the pathway route. Where no innerduct exists, install new 1" (25 mm) or larger plenum-rated innerduct with pull-line installed.
 - 3. At the building's point of egress to OSP conduit paths, continue all cable runs in new 1.5" (38mm) or larger underground schedule-40 conduit provisioned to the destination facility.
 - 4. Only where existing low-voltage OSP conduit provisions are 2" or larger, include and install new minimum 1" orange innerduct or Maxcell 3-pocket fabric innerduct in a point-to-point fashion between all respective pull-points and securely tie them off at each end. Run new backbone fiber(s) within the new innerduct segment(s).
 - 5. Coordinate with SI-OPS and SI-OCIO for final Headend Room, Rack and Patch Panel destination and the existing pathway systems to utilize in route to that point-of-origin.

6. Additionally coordinate with NMAH/NHB high-voltage contractor regarding use of existing low-voltage OSP conduit between existing building point-of-entry and the T4 Manhole for all associated fiber pass-thru work.
- B. Wiring within Equipment Panel Enclosures internal to project facility: Bundle, lace, and train cables within enclosures. Connect cable conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending. Externally provide minimum 12" (300 mm) coil of cable service slack prior to entry to the equipment enclosure.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
1. Comply with TIA-568-1.D and TIA-568-3.D
 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 4. Cables may not be spliced except for termination purposes. 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.
 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 7. 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.
 8. Cold-Weather Installation: Bring cable to room temperature before unreeling. Heat lamps shall not be used for heating.
 9. In the communications rooms, provide a 10 foot (3 m) long service loop on each end of cable.
 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 11. Terminate cable by means of pigtail fusion splicing on connecting hardware that is rack or cabinet mounted.
 12. Placement of Cable into Conduit Risers: Provide conduit risers as indicated on the plans. Use Kellum grips and/or other hanger devices to support the vertical drop of cable and prevent any possible kinking of the cable after installation.
 13. Minimum Bend Radius: For static storage, do not bend the cable at any location to less than ten times the outside diameter of the cable or as recommended by the manufacturer. During installation, the cable shall not be bent at any location to less than twenty times the outside diameter of the cable or as recommended by the manufacturer.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in communications spaces with terminating hardware and interconnection equipment.
 2. Do not run cable through structural members or in contact with pipes, ducts, or other potentially damaging items.

- D. Installation of Cable Routed Exposed under Raised Floors (only as required):
 - 1. Install Indoor/Outdoor 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.
- E. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping." Do not begin installation work until certificates of conformance or compliance, manufacturer's catalog data, and details for fire stopping of penetrations and joint systems showing compliance with the appropriate UL Design Number are approved by the Office of Safety Health and Environmental Management Fire Protection Engineer.
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C.
 - 1. Color-code cross-connect fields and apply colors to security data service backboards, connections, covers, and labels.
- B. Cable Schedule: Install in a prominent location in each security 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.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for communications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables.
- D. 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. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 3. Label each unit and field within distribution racks and frames.
 - 4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.
- E. 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 606-C, for the following:
 - 1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect optical fiber 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-568-1.D.
2. Visually inspect cable placement, cable termination, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-3.D. 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) Test Single-mode link measurements at 1310 and 1550 nm in both directions. Use procedures specified in TIA-526-7-A.1 (OFSTP-7), Measurement of Optical Power Loss for installed Single-mode fiber cable plant.
 - 2) Multimode measurements: For OM-3,-4,-5 cable types, test at 850nm in both directions according to TIA-526-14-B, Method B, One Reference Jumper.
 - 3) Otherwise for OM-1 or OM-2 cable types based on LED (non-VCSEL) application use by Owner, test at both 850nm and 1300nm in one direction only when commissioning.
 - 4) All attenuation test results shall be less than those calculated according to equation in TIA-568-3.D for the cable type under test.
 - c. OTDR Test: Perform optical time domain reflectometer tests in the 850 to 1300 nanometers wavelength band on the fiber optic cable after it is installed. Calibrate the optical time domain reflectometer to show anomalies of zero point two (0.2) dB as a minimum. If the optical time domain reflectometer test results are unsatisfactory, replace unsatisfactory segments with a new segment of cable at no cost to the Owner. Test the new segment of cable to demonstrate acceptability. Furnish photographs of the traces to the Owner for each circuit.

- B. Document data for each measurement. Print data for submittals 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 submit electronically.
- C. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Validation: Test random fiber strands at Owner/Engineer's discretion to confirm validity of test results. Contractor to perform cable testing in presence of Owner/Engineer using Contractor staff and utilizing same test equipment that was used for final acceptance testing by Contractor. Owner reserves the right to validate up to 100% of installed optical fiber.

G. Warranty

1. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 271300.10

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Related documents
 - 2. Description
 - 3. Performance requirements
 - 4. UTP cable and hardware
 - 5. Cabling system identification

1.2 RELATED DOCUMENTS

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

1.3 DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the communications outlets/connectors (Drop-set) and the horizontal cross-connect located in the remote far-end telecom equipment enclosure panel. This cabling and its connecting hardware are called the "permanent link".
- B. The system chosen shall meet the following specifications:
 - 1. The balanced twisted-pair cable shall be available in bonded pair and non-bonded pair configurations.
 - 2. The balanced twisted-pair cabling system shall be an end-to-end manufacturer's warranted Category 6A system solution capable of supporting 10G Gigabit Ethernet networking with additional performance margin up to 500 MHz for a 4-connector, 100 m (328 ft) channel.

NOTE: 4-pair connector refers to one Drop-set and corresponding cross-connect field or patch panels in a remote Telecommunications equipment enclosure.

- C. The maximum allowable "horizontal link" cable length is 295 feet (90 meters). This allows for an extra 33 feet (10m) for the entire channel length of 328 feet. The 33 feet provides for the maximum length of up to 16 feet at the workstation equipment, and 7 feet for horizontal patch-connect, along with a 1-foot service loop supported externally to the remote telecom equipment enclosure.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Install indoor plenum cable in all environmental air spaces, regardless of plenum/non-plenum ratings. Where indoor cable extends its route either on the external side of the building structure, across horizontal/vertical supports, in buried conduit, or in any other manor exposed to groundwater, sunlight and/or elements of weather, the entire run length of shall be accomplished with Indoor/Outdoor plenum rated cable of the same performance category.
- B. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-1.D when tested according to test procedures of this standard.
- C. At a minimum, the balanced twisted-pair cabling system shall exceed the key performance parameters for Cat6A found in ANSI/TIA-568-2.D Category 6A standard over the specified frequency ranges by the values listed below. The balanced twisted-pair cabling system shall also meet all the requirements of ISO/IEC 11801 Edition 2.0 2002-09.

Parameter	Margin			
	100 MHz	200 MHz	250 MHz	500 MHz
Insertion loss	1.1 dB	1.5 dB	1.8 dB	3%
Return loss ^(a)	4.0 dB	4.0 dB	4.0 dB	2.0 dB
PSNEXT	4.0 dB	4.0 dB	4.0 dB	2.0 dB
PSACR-N	5.1 dB	5.5 dB	5.8 dB	1.5 dB
PSACR-F (formerly PSELFEXT)	5.5 dB	5.5 dB	5.5 dB	8.0 dB

- D. Values represent System 10GX channel margin against TIA/EIA-568-2.D Category 6A standard. The margin is the additional headroom (in dB) compared to the minimum specified value for Category 6A at each frequency point over the specified frequency range.
- E. The worst case margin is determined at the frequency where the measured data point is closest to the limit line. This margin applies for a worst-case, 4-connector, 100-meter channel configuration.
 - PSNEXT = Power-sum near-end crosstalk
 - PSACR-F = Power-sum attenuation-to-crosstalk ratio far-end
 - PSACRN = Power-sum attenuation-to-crosstalk ratio near-end
- F. The cable conductors shall be 23 AWG solid copper.

G. The minimum bend radius shall be 25 mm (1 in) for CMP-rated cable.

H. The guaranteed values for the primary transmission characteristics of the cable are as follows:

1.	Maximum DC resistance (at 20°C)	7.4 ohms/100 m (328 ft)
2.	Maximum DC resistance unbalance	3%
3.	Maximum mutual capacitance	5.7 nF/100 m (328 ft)
4.	Maximum capacitance unbalance (pair to ground)	50 pF/100 m (328 ft)
5.	Maximum propagation delay skew	35 ns/100 m (328 ft)
6.	NVP – plenum	68% @ 10 MHz

DC = Direct current

NVP = Nominal velocity of propagation

I. 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.

J. All cable used on the project shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

K. 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.

L. Provide cable, patch cords and hardware solutions matched and coordinated by the manufacturers. Cables shall be terminated and patched with connecting hardware of same Category or higher.

M. Provide cables with imprinted cable type, length, category, pair and/or strand count.

N. General project requirements are to provision cable hardware for the number of cables terminated on the patch panel housings. Include a 25 percent spare capacity reserve either with pre-populated panel's integral with connector bodies, lugs and jacks, or by the use of "blank plates" to fill the vacant slots representing future growth reserves. Where a new patch panel or enclosure unit would be necessary to fulfill the "future reserve" requirement, contractor may use black powder coated 19" rack-mount (1 or 2U) Blank Panels in order to hold these vacant rack mount spaces for future panel placement.

1. Due to the spacial challenges anticipated within the telecom equipment enclosure panel related to this project, and in lieu of typical rack- or wall-mount patch panel systems, provision at least one modular dual-gang (8-port min/12-port max) metallic faceplate along with minimum 4-11/16" square x 2-1/4" deep backbox having grommeted knockouts for cable entry/exit. UTP jacks to match those referenced below.

2.2 UTP CABLE AND HARDWARE

A. Provide CAT-6A 100-ohm, four-pair UTP cable.

1. Cable color: Submit for Contracting Officer Representative's discretion, unless Owner preferences are noted within this section or on the drawings.

B. Connecting Hardware:

1. Provide modular connecting blocks and patch panels with 110-style IDC punch-down caps or crimp tools.
2. Patch panels to have clear window displays covering outlet labels.
3. Jacks and Jack Assemblies: 100-ohm, balanced, modular, color-coded, four-pair, eight-position units with integral IDC-type terminals. Match Category to cable.
4. Workstation Outlets:
 - a. Four port-connector assemblies mounted in single-gang faceplate.
 - b. High impact plastic with clear label lens.
 - c. Wall phone plates at Contracting Officer Representative discretion.
 - d. Color to be at Contracting Officer Representative's discretion, unless Owner preferences are noted within this section or on the drawings.
 - e. Include modular faceplate connectors to accommodate any combination of UTP, and equipment cords at the work area or device end. Outlet receptacles and equipment cords to be deployed within plenum ceiling cavity spaces must be plenum-rated.
 - f. Provide flush mounting jacks capable of positioning the cord to either a 90- and/or a 45-degree angle.
 - g. For all voice/data/wireless device locations and corresponding interconnects, the typical faceplate, female RJ45 outlet, and equipment cord requirement at endpoint device may be negated in lieu of appropriate length factory pre-terminated cordage and modular 8P8C pass-thru connector modules capable of accepting male RJ45 plug connections each end of the faceplate, along with MPTL direct-connects made to the endpoint station device.
 - h. Provide machine printed, adhesive wrap-around labeling on all cable shields within 2"-3" of connected endpoint.
 - i. Provide machine printed adhesive-tape labels for use behind plastic label windows at the faceplate receptacles.

C. Patch Cords:

1. Terminated to the T568B pin-out specifications.
2. Factory-made, four-pair cables terminated with eight-position modular plug at each end.
3. Patch cords shall have bend-relief-compliant boots and latch guards to protect against snagging.
4. Inventory and color at Contracting Officer Representative discretion, unless Owner preferences are noted within this section or on the drawings.

2.3 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory tested UTP cables on reels or in boxes according to ANSI/TIA-568-2.D.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF CABLES

- A. Cables to be home run to the space serving TR.
- B. Coordinate layout and installation of telecommunications cabling with Contracting Officer Representative telecommunications and LAN equipment and service suppliers.
- C. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- D. Bridged taps and splices shall not be installed in the horizontal cabling.
- E. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.
- F. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- G. 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.
 - 1. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- H. Comply with NECA 1.
- I. Comply with ANSI/TIA-568-1.D.
- J. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
- K. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- L. 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.
- M. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
- N. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
- O. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

- P. Group connecting hardware for cables into separate logical fields.
- Q. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-D 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 6 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 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.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 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.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.2 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-C.
1. Administration Class: 2.
 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
 3. Legend: Machine printed, in the field, using adhesive-tape label for plastic faceplates. Include telecommunications room (TR) identifier.
 - a. Data: TR-D001, D002, etc.
 - b. Voice: TR-V001, V002, etc.
 - c. Wall Phone: TR-WP001, WP002, etc.
- B. For painting fire-resistant plywood (FRT), do not paint over manufacturer's label.

- C. 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.
- D. 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 ANSI/TIA-606-C. Furnish electronic record of all drawings, in native software format selected by Contracting Officer Representative.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Identification of connector fields within Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.
 - 3. 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.
- F. 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 ANSI/TIA-606-C.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Visually inspect UTP 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-568-0.D.
 - 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 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 ANSI/TIA-568-2.D. 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. UTP Performance Tests:

- a. Test each outlet according to ANSI/TIA-568-2.D
 - b. Wire map
 - c. Length (physical vs. electrical, and length requirements)
 - d. Insertion loss
 - e. Near-end crosstalk (NEXT) loss
 - f. Power sum near-end crosstalk (PSNEXT) loss
 - g. Equal-level far-end crosstalk (ELFEXT)
 - h. Power sum equal-level far-end crosstalk (PSELFEXT)
 - i. Return loss
 - j. Propagation delay
 - k. Delay skew
6. Final Verification Tests: Perform verification tests for UTP 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.
- B. 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.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 PATCH CORDS AND INTERCONNECTS

- A. All Horizontal interconnects shall be accomplished with contractor provided and installed factory-terminated UTP patch cords as appropriate to the final drop count quantities of the project's overall installation.

1. Provide 100% of all Categorized Patch Cords in the following lengths and percentage quantities based on final termination counts at both the TR and WAO/Device endpoints:
2. UTP Copper Cord Types: Cat6A (Color-1) Cat6A (Color-2)

End-Point Locations:		TR	WAO	TR	WAO
Lengths/Percentages:					
3.	3-Ft (1m)	100%	0%	100%	0%
4.	7-Ft (2m)	0%	50%	0%	50%
5.	10-Ft (3m)	0%	50%	0%	50%
6.	13-Ft (4m)	0%	0%	0%	0%
7.	16-Ft (5m)	0%	0%	0%	0%

3.5 DEMONSTRATION

- A. Train Contracting Officer Representative 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.

3.6 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 271500

SECTION 271500.10 - SECURITY HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Description
 2. Performance requirements
 3. UTP cable and hardware
 4. Cabling system identification

1.2 RELATED DOCUMENTS

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

1.3 DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the security device outlets/connectors (Drop-set) and the horizontal cross-connect located in the remote far-end security equipment panel. This cabling and its connecting hardware are called the "permanent link".
- B. The system chosen shall meet the following specifications:
1. The balanced twisted-pair cable shall be available in bonded pair and non-bonded pair configurations.
 2. The balanced twisted-pair cabling system shall be an end-to-end manufacturer's warranted Category 6A system solution capable of supporting 10G Gigabit Ethernet networking with additional performance margin up to 500 MHz for a 4-connector, 100 m (328 ft) channel.

NOTE: 4-pair connector refers to one Drop-set and corresponding cross-connect field or patch panels in a remote Security Communications equipment enclosure.

- C. The maximum allowable "horizontal link" cable length is 295 feet (90 meters). This allows for an extra 33 feet (10m) for the entire channel length of 328 feet. The 33 feet provides for the maximum length of up to 16 feet at the workstation equipment, and 7 feet for horizontal patch-connect, along with a 1-foot service loop supported externally to the remote equipment enclosure.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Install ISP/OSP (dual indoor/outdoor rated) plenum cable throughout all areas of this project and in all environmental air spaces, regardless of plenum/non-plenum ratings. Where indoor cable extends its route either on the external side of the building structure, across horizontal/vertical supports, in buried conduit, or in any other manor exposed to groundwater, sunlight and/or elements of weather, the entire run length of shall be accomplished with Indoor/Outdoor plenum rated cable of the same performance category. Where copper cabling makes use of underground conduit or similar pathways considered exposed and susceptible to lighting surges, provide individual surge protection devices as specified herein.
- B. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-1.D when tested according to test procedures of this standard.
- C. At a minimum, the balanced twisted-pair cabling system shall exceed the key performance parameters for Cat6A found in ANSI/TIA-568-2.D Category 6A standard over the specified frequency ranges by the values listed below. The balanced twisted-pair cabling system shall also meet all the requirements of ISO/IEC 11801 Edition 2.0 2002-09.

	Margin			
Parameter	100 MHz	200 MHz	250 MHz	500 MHz
Insertion loss	1.1 dB	1.5 dB	1.8 dB	3%
Return loss ^(a)	4.0 dB	4.0 dB	4.0 dB	2.0 dB
PSNEXT	4.0 dB	4.0 dB	4.0 dB	2.0 dB
PSACR-N	5.1 dB	5.5 dB	5.8 dB	1.5 dB
PSACR-F (formerly PSELFEXT)	5.5 dB	5.5 dB	5.5 dB	8.0 dB

- D. Values represent System 10GX channel margin against TIA/EIA-568-2.D Category 6A standard. The margin is the additional headroom (in dB) compared to the minimum specified value for Category 6A at each frequency point over the specified frequency range.
- E. The worst case margin is determined at the frequency where the measured data point is closest to the limit line. This margin applies for a worst-case, 4-connector, 100-meter channel configuration.

PSNEXT = Power-sum near-end crosstalk
 PSACR-F = Power-sum attenuation-to-crosstalk ratio far-end
 PSACRN = Power-sum attenuation-to-crosstalk ratio near-end

- F. The cable conductors shall be 23 AWG solid copper.
- G. The minimum bend radius shall be 25 mm (1 in) for CMP-rated cable.
- H. The guaranteed values for the primary transmission characteristics of the cable are as follows:
- | | | |
|----|---|-------------------------|
| 1. | Maximum DC resistance (at 20°C) | 7.4 ohms/100 m (328 ft) |
| 2. | Maximum DC resistance unbalance | 3% |
| 3. | Maximum mutual capacitance | 5.7 nF/100 m (328 ft) |
| 4. | Maximum capacitance unbalance
(pair to ground) | 50 pF/100 m (328 ft) |
| 5. | Maximum propagation delay skew | 35 ns/100 m (328 ft) |
| 6. | NVP – plenum | 68% @ 10 MHz |
- DC = Direct current
NVP = Nominal velocity of propagation
- I. 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.
- J. All indoor/outdoor cable used on the project shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
1. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- K. 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.
- L. Provide cable, patch cords and hardware solutions matched and coordinated by the manufacturers. Cables shall be terminated and patched with connecting hardware of same Category or higher.
- M. Provide cables with imprinted cable type, length, category, pair and/or strand count.
- N. General project requirements are to provision cable hardware for the number of cables terminated on the block or patch panel housings. Include a 25 percent spare capacity reserve either with pre-populated panel's integral with connector bodies, lugs and jacks, or by the use of "blank plates" to fill the vacant slots representing future growth reserves. Where a new patch panel or enclosure unit would be necessary to fulfill the "future reserve" requirement, contractor may use black powder coated 19" rack-mount (1 or 2U) Blank Panels in order to hold these vacant rack mount spaces for future panel placement.
1. Due to the special challenges anticipated within the security equipment enclosure panel related to this project, and in lieu of typical rack- or wall-mount patch panel systems, provision at least one modular dual-gang (8-port min/12-port max) metallic faceplate along with minimum 4-11/16" square x 2-1/4" deep backbox having grommeted knockouts for cable entry/exit. UTP jacks to match those referenced below.

2.2 UTP CABLE AND HARDWARE

- A. Provide CAT-6A 100-ohm, four-pair UTP cable.
- ISP/OSP cable color: Generally available in Black color only. However, if available in other colors, please submit for Contracting Officer Representative's discretion, unless Owner preferences are noted within this section or on the drawings.
- B. Connecting Hardware:
- Provide modular connecting blocks and patch panels with 110-style IDC punch-down caps or crimp tools.
 - Patch panels to have clear window displays covering outlet labels.
 - Jacks and Jack Assemblies: 100-ohm, balanced, modular, color-coded, four-pair, eight-position units with integral IDC-type terminals. Match Category to cable.
 - Workstation Outlets:
 - Two port-connector assemblies mounted in single-gang faceplate.
 - High impact plastic with clear label lens.
 - Color to be at Contracting Officer Representative's discretion, unless Owner preferences are noted within this section or on the drawings.
 - Include modular faceplate connectors to accommodate any combination of UTP, and equipment cords at the work area or device end. Outlet receptacles and equipment cords to be deployed within plenum ceiling cavity spaces must be plenum-rated.
 - Provide flush mounting jacks capable of positioning cords to a 90- or 45-degree angle.
 - For all exterior device locations and corresponding OSP cable interconnects, the typical faceplate, female RJ45 outlet, and equipment cord requirement at endpoint device is to be negated in lieu of exterior terminations utilizing a modular, direct-connect male RJ45 plug (aka MP1L) made directly to end of station cable run.
 - Provide machine printed, adhesive wrap-around labeling on all cable shields within 2"-3" of connected endpoint.
 - Provide machine printed adhesive-tape labels for use behind plastic label windows at the faceplate receptacles.
- C. Patch Cords:
- Terminated to the T568B pin-out specifications.
 - Factory-made, four-pair cables terminated with eight-position modular plug at each end.
 - Patch cords shall have bend-relief-compliant boots and latch guards to prevent snagging.
 - Inventory and color at Contracting Officer Representative discretion, unless Owner preferences are noted within this section or on the drawings.

2.3 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory tested UTP cables on reels or in boxes.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF CABLES

- A. Cables to be home run to the space serving SCR.
- B. Coordinate layout and installation of communications cabling with Contracting Officer Representative communications and LAN equipment and service suppliers.
- C. Coordinate communications outlet/connector locations with location of power receptacles at each work area.
- D. Bridged taps and splices shall not be installed in the horizontal cabling.
- E. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.
- F. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- G. 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.
 - 1. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- H. Comply with NECA 1.
- I. Comply with ANSI/TIA-568-1.D.
- J. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
- K. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- L. 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.
- M. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
- N. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
- O. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in communications spaces with terminating hardware and interconnection equipment.
 - 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

- P. Group connecting hardware for cables into separate logical fields.
- Q. Separation from EMI Sources:
 - 1. Comply with BICSI TDMM and TIA-569-D 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 6 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 - 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.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 - 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.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.2 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-C.
 - 1. Administration Class: 2.
 - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
 - 3. Legend: Machine printed, in the field, using adhesive-tape label for plastic faceplates. Include security communications room (SCR) identifier.
 - a. Security Data: SCR-D001, D002, etc.
- B. For painting fire-resistant plywood (FRT), do not paint over manufacturer's label.
- C. 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.

- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for communications 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 ANSI/TIA-606-C. Furnish electronic record of all drawings, in native software format selected by Contracting Officer Representative.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Identification of connector fields within Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.
 - 3. 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.
- F. 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 ANSI/TIA-606-C.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Visually inspect UTP 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-568-0.D.
 - 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 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 ANSI/TIA-568-2.D. 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. UTP Performance Tests:
 - a. Test each outlet according to ANSI/TIA-568-2.D
 - b. Wire map
 - c. Length (physical vs. electrical, and length requirements)
 - d. Insertion loss

- e. Near-end crosstalk (NEXT) loss
 - f. Power sum near-end crosstalk (PSNEXT) loss
 - g. Equal-level far-end crosstalk (ELFEXT)
 - h. Power sum equal-level far-end crosstalk (PSELFEXT)
 - i. Return loss
 - j. Propagation delay
 - k. Delay skew
6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
- a. Data Tests: These tests assume the Security 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.
- B. 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.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.4 PATCH CORDS AND INTERCONNECTS
- A. All Horizontal interconnects shall be accomplished with contractor provided and installed factory-terminated UTP patch cords as appropriate to the final drop count quantities and interconnect lengths of the project's overall security installation.
- 3.5 DEMONSTRATION
- A. Train Contracting Officer Representative 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.
- 3.6 WARRANTY
- A. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

END OF SECTION 271500.10

SECTION 27 4116 – AUDIOVISUAL SYSTEMS AND EQUIPMENT

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 AV series contract drawings and single-line diagrams.
- C. All Telecommunications series contract drawings.
- D. See Division 27 for communications cabling, cabling pathways, terminations and physical mounting of cable hangers and cable trays.

1.2 SUMMARY

- A. Description of Work: Work of this Section includes, but is not limited to, the following:
- B. The Contractor shall provide labor, materials and equipment necessary to provide complete audiovisual systems defined in this specification.
- C. The Contractor shall be responsible for delivering a turnkey system to the Owner before the occupancy date specified.
- D. The Contractor shall support the Owner in their effort to complete the project in accordance with the aforementioned schedule. Contractor is required to participate in all weekly construction meetings as a full member of the project team.
- E. The Contractor shall furnish all equipment and materials, whether specifically mentioned herein or not, to ensure a complete and operating system. The NIC (Not in Contract) and OFE (Owner Furnished Equipment) items and materials are specifically exempted from this requirement. The Contractor shall coordinate with “others” on their components when interfaced, or integrated, with other Trades, or Owner; these are marked in Contract Documents as NIC or OFE.
- F. The Contractor shall generate all shop drawings and information for the complete installation and wiring of the system. The Contractor shall provide (or sub-subcontract) for the onsite installation and wiring, and shall provide ongoing supervision and coordination during the implementation phase.
- G. The Contractor shall be responsible for the initial adjustment of the systems as herein prescribed and shall provide all test equipment for the system checkout and acceptance tests.
- H. Supplier/Installer is required to provide client onsite training in the operation and maintenance of the systems for personnel designated by the C.O.R. (Contracting Officer’s Representative).

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. See Division 26 sections for all floor boxes, table boxes, conduits, wire ways, connection boxes, pull boxes, junction boxes, and outlet boxes permanently installed in walls, floors, and ceilings.
- B. See Division 26 sections for all electrical breaker panels required to power the audiovisual systems.
- C. Furniture and cabinetry in support of audiovisual technology.
- D. Heating and Air Conditioning equipment in support of audiovisual technology.
- E. Room lighting equipment and electronic dimming and switching equipment in support of audiovisual presentations and electronic conferencing.

1.4 APPLICABLE CODES AND STANDARDS

- A. The following international codes and standards are applicable to this project:
 - 1. All local codes and regulations shall be strictly observed. Standards listed below shall be the latest edition and adhered to as applicable.
 - 2. ANSI/INFOCOMM 10:2013, Audiovisual Systems Performance Verification
 - 3. ANSI/INFOCOMM 2M-2010
 - 4. ANSI/INFOCOMM 3M-2011, Projected Image System Contrast Ratio
 - 5. ANSI/INFOCOMM 4:2012, Audiovisual Systems Energy Management
 - 6. AVIXA A102.01:2017 (Formerly ANSI/INFOCOMM A102.01:2017), Audio Coverage Uniformity in Listener Area
 - 7. CEA/CEDIA/INFOCOMM J-STD-710, Audio, Video and Control Architectural Drawing Symbols Standard
 - 8. AVIXA F501.01:2015 (Formerly INFOCOMM F501.01:2015), Cable Labeling for Audiovisual Systems
 - 9. AVIXA V202.01:2016 (Formerly ANSI/INFOCOMM V202.01:2016), Display Image Size for 2D Content in Audiovisual Systems
 - 10. BICSI- Standard for Installing Commercial Building Telecommunications Cabling; Latest edition
 - 11. BICSI TDMM - Telecommunications Distribution Methods Manual; Latest edition
 - 12. TIA-526-7 (OFSTP-7)-2002+A1:2008, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - 13. TIA-526-14-B-2010 (OFSTP-14), Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 Edition 2, Fiber-Optic Communications Subsystem Test Procedure- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement.
 - 14. ANSI/TIA-568-C.0-2009+A1:2010+A2:2012, Generic Telecommunications Cabling for Customer Premises.
 - 15. ANSI/TIA-568-C.1-2009+A1:2012, Commercial Building Telecommunications Cabling Standard.
 - 16. ANSI/TIA-568-C.2-2009+A1:2010, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - 17. ANSI/TIA-568-C.3-2009+A1:2011, Optical Fiber Cabling Components Standard.
 - 18. ANSI/TIA-568-C.4-2011, Broadband Coaxial Cabling and Components Standard.
 - 19. ANSI/TIA-569-C-2012, Telecommunications Pathways and Spaces.
 - 20. ANSI/TIA/EIA-598-C-2005, Optical Fiber Cable Color Coding.
 - 21. ANSI/TIA-606-B-2012, Administration Standard for Commercial Telecommunications Infrastructure.

22. ANSI-J-STD-607-A
23. ANSI/TIA-607-B-2011, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
24. ANSI/TIA-1152–2009, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
25. ANSI/TIA-1183–2012, Test Fixtures for Balun-Less Measurements of Balanced Components and Systems.
26. NFPA 70- National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
27. Underwriters Laboratories, Inc. (UL)
28. ASTM International
29. NEMA – National Electrical Manufacturers Association
30. NECA– National Electrical Contractors Association Standards for Good Workmanship
31. ISO/IEC 11801

1.5 DEFINITIONS

- A. Within this specification, the following definitions shall apply:
1. The term "Owner" shall refer to the Smithsonian Institution.
 2. The term "General Contractor" shall refer to the General Contractor.
 3. The term "Architect" shall refer to Architect of Record, Hartman-Cox.
 4. The term, "Consultant" or "AV consultant" shall refer to AV Consultant working for the Architect of Record, GHD, Inc.
 5. The term "Contractor" shall refer to the Audiovisual Systems Contractor who has been awarded the contract for the subject job and who has responsibility for performance of the work specified herein.
 6. The term COTR shall refer to the Owner's contracting office technical representative.
 7. The term "Specified elsewhere" shall refer to material and work which is related to this contract and for which the AV contractor is not responsible except as otherwise detailed herein. Some or all of these items may be included in the overall electrical contract.
 8. The term "OFE" shall refer to "Owner Furnished Equipment", which will be provided by the Owner to the Contractor. The Contractor shall be responsible for installing and integrating this equipment as detailed herein.
 9. The term "NIC" shall refer to "Not In Contract", scope not included in the AV contractor's scope of work.
 10. The term "infrastructure" shall refer only to future or planned equipment items and capabilities of the audiovisual system. The Contractor is required to provide reasonable and appropriate means to facilitate the future integration of these components within the system design. Wherever possible, the systems design specifications include provisions for these anticipated expansions. The Contractor shall ensure that the installation will readily support these items, including all system cabling to the proposed equipment locations, appropriate and available space for said equipment within new equipment racks, credenzas, and lecterns; with existing TR's, and audiovisual control system software anticipating said future items.
 11. The term "shall" is mandatory; the term "will" is informative; the term "should" is advisory; and the term "provide" means furnish and install.

1.6 SUBMITTALS

- A. Three (3) submittals are required:
1. Product datasheets

2. Shop Drawings/ Touch panel GUI
 3. Final Documentation
- B. Submittal 1 – Product datasheets
1. Product data: Manufacturer’s product information and data sheets for all equipment items, cabling and materials provided.
 - a. Include an index/ table of contents (TOC) that includes make, model, page number, and applicable room type or number. Submittal without an index or TOC will be returned rejected.
 - b. Organize datasheets alphabetically by manufacturer.
 - c. Datasheets shall be from the OEM and not resellers.
 - d. Do not include equipment manuals.
 - e. Only include product datasheets for equipment once in the submittal, no matter how many times or systems that piece of equipment is used in the project.
 - f. Highlight only equipment specified for use on project.
 - g. Provide proof the AV Contractor is authorized to resell the products specified.
- C. Submittal 2 – Shop Drawings
1. For purposes of quality assurance and performance verification, prior to fabrication the Contractor shall submit (3) three copies of the following information for approval by the Owner, Architect and AV Consultant. Drawings shall be reviewed and stamped by the Lead Designer, who shall hold a current CTS or CTS-D certification. Drawing submittal shall be on reproducible media. This information shall include, but is not limited to, the following:
 - a. Line drawings - Complete system construction and point to point wiring schematic drawings, including all component values and showing complete letter and number identification of all wire and cable as well as jacks, terminals, and connectors, and device system names.
 - b. Floor plans
 - c. Reflective ceiling plan drawings showing placement of all ceiling mounted equipment.
 - d. Elevation drawings
 - e. Touch panel Graphical User Interface (GUI)
- D. Submittal 3 - Final Documentation
1. At the completion of the installation, the Contractor shall submit final "as-built" documentation, including the following:
 - a. Equipment manufacturer's operation and maintenance manuals for each piece of equipment. Product data sheets shall be collated and indexed alphabetically and sorted per system in a D-type three ring binder.
 - b. Same Equipment manufacturer's operation and Maintenance manuals, and Training Manual, described above for Shop Drawings. These documents shall be electronically saved as Adobe Acrobat PDF files onto a CD-ROM. The CD-ROM shall be labeled for "Section 274116 AUDIOVISUAL, AS-BUILT Documentation, Operation and Maintenance Manuals" with the project name, contractor's name and AV Contractor contact info and date of issue.
 - c. "As built" drawings that include any updates (red-lines) made in the field to the shop drawings. This package to install final versions of all shop drawings and is to include, but not limited to, line, elevation, rack, floor, including floor and reflected ceiling plans showing equipment and device locations and conduit pathways, system functional block drawings including all input and output circuit cable and terminal block numbers, all jack field circuit I.D. designations and every equipment item required for the system configuration. The drawings shall include labeling for "Section 274116, Audiovisual,

- AS-BUILT Documentation" with the project name, contractor's name and Contractor contact info and date of issue.
- d. Same "As built" drawings described above for every equipment item required for the system configuration, electronic files, saved as editable AutoCAD 2010 (or newer version) and also as Adobe Acrobat PDF files onto a CD-ROM. The CD-ROM shall be labeled for "Section 274116, Audiovisual, AS-BUILT Documentation, System Drawings" with the project name, contractor's name and AV Contractor contact info and date of issue.
 - e. A System Operation and Training Maintenance Manual. This manual shall be produced by the Contractor specifically for the systems detailed herein and provided in Microsoft Word (editable) and Adobe Acrobat PDF files onto a CD-ROM. The CD-ROM shall be labeled for "Section 274116, Audiovisual, AS-BUILT Documentation, System Drawings" with the project name, contractor's name and AV Contractor contact info and date of issue.
 - f. The "Operation" section shall describe all typical procedures necessary to activate each system to provide for the functional requirements as listed under the Detailed Specifications.
 - g. The reader of this manual shall be assumed to be technically competent, but unfamiliar with this particular facility. It is estimated that this manual will require a minimum of 5 pages for each room and functional system configuration.
 - h. The "Maintenance" section shall provide a recommended maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where inadequate information is provided by the manufacturer, the Contractor shall provide the information necessary for proper maintenance.
 - i. Detailed equipment list with a minimum of the following information: Room number, location, CLIN, manufacturer, model, description, MSRP, serial number, manufacturer warranty term, manufacturer warranty start date, manufacturer warranty end date, delivery date, and system acceptance date.
 - j. All documentation to be provided within 14 calendar days of the room's acceptance.

1.7 WARRANTY

- A. The Contractor shall provide a written warranty on the entire system, installation workmanship, materials employed and on the individual pieces of equipment installed. The system warranty shall be for one (1) year commencing from the date of final system acceptance by the Owner. This warranty shall obligate the Contractor to provide all equipment, material, and labor during the warranty period, in the event of system or equipment malfunction.
- B. To maintain certain manufacturers' warranties, said equipment must be installed, aligned and serviced by those authorized by said manufacturer to perform those duties. If the Contractor is not authorized by said manufacturer, it is his sole responsibility to make the appropriate arrangements and bear all cost and consequences thereof.
- C. All video and computer image display panels, image projection products and projection lamps are warranted only to the extent as provided for under the manufacturer's warranties and guarantees.
- D. All manufacturer's equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of contractor modified equipment, the manufacturer's warranty is normally voided. In such cases, the Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.

1.8 SERVICE AND MAINTENANCE

- A. **WARRANTY PERIOD:** During the initial one-year warranty period, the audiovisual contractor shall provide onsite service, repair and maintenance for the audiovisual system. First year service and maintenance shall be provided at a fixed price, regardless of the number of service visits required to maintain system operation and performance, including video projector alignment. On the Master Recapitulation of Costs, enter your first year service contract costs. During the warranty period, the Contractor shall report all parts replaced/repaired; labor hours spent for actual work, and reason for repair/replacement. The Contractor shall provide documentation of maintenance and repairs to the Owner prior to asset turnover.
- B. **FIRST YEAR SERVICE AND MAINTENANCE** consists of telephone support and assistance, on-site services and preventative maintenance inspections. In all cases, the audiovisual vendor shall provide knowledgeable and capable staff technicians in the performance of all tasks required.
- C. **TELEPHONE ASSISTANCE:** Vendor shall respond via telephone within two hours to any request for service. This first contact should outline the nature of the problem or functional anomaly. The vendor shall make available an individual knowledgeable with the installed system who can address specific system issues described by system operators.
- D. **NON-EMERGENCY ON-SITE SERVICE:** The vendor shall provide capable technicians for on-site service of systems equipment or control software within 1-business day of reporting the issue if the issue cannot be resolved over the phone. In all cases, the technicians dispatched must be familiar with the installed system with complete knowledge of the products used in the systems configuration. Technicians dispatched must have complete ability to address the nature of the system anomaly or performance difficulty described.
- E. **EMERGENCY ON-SITE PROVISION:** During the first year service contract, the vendor may be called upon to provide on-site service on an emergency basis. For whatever reasons, the Owner may request a qualified technician be onsite to perform service within 4 hours from notification. This emergency service should be available 7 days per week, 24 hours per through a communications hierarchy established by the Owner and Contractor.
- F. **PREVENTATIVE MAINTENANCE INSPECTIONS (PMI):** This service shall include a minimum of four (4) quarterly visits to perform operation checks of the equipment in each room; to clean screens, projector lenses and other critical surfaces; to lubricate moving parts as recommended by the respective manufacturers; and to adjust and align projectors to maintain optimum registration and focus. Additional service visits, above the four visits above, are included in the first year warranty, subject to the time response obligations outlined above. No limit to the quantity of service visits is expressed or implied.

1.9 DELIVERY, STORAGE & HANDLING

- A. Refer to SECTION 01600 – MATERIAL AND EQUIPMENT for provisions and requirements pertaining to Product Delivery, Storage and Handling.
- B. Costs of all shipping to the site, and of all unusual storage requirements, shall be borne by the Contractor. It shall be the responsibility of the Contractor to make appropriate arrangements, and to coordinate with authorized personnel at the site, for the proper acceptance, handling, protection, and storage of equipment so delivered.

- C. Until site conditions are ready for installation of the AV equipment, same AV equipment must be received and stored offsite by the Contractor in suitable environmental conditions for sensitive electronic equipment.
- D. A detailed equipment list to be provided to the Owner before any deliveries with a minimum of the following information: Room number, location, CLIN, manufacturer, model, description, MSRP, serial number, manufacturer warranty term, manufacturer warranty start date, manufacturer warranty end date, and delivery date.

1.10 UNION LABOR

- A. The Contractor is responsible for verifying with the General Contractor if Union labor is required for this project. If required, the vendor shall secure authorized union labor for the tasks and activities requiring union labor as needed. The costs for union labor should be included with the Contractor's proposal.

1.11 PERMITS

- A. The Contractor shall secure all appropriate permits for low voltage cable installation required by the local jurisdiction. Said documents shall be provided to the Consultant and Owner's project manager prior to the commencement of on-site installation. Costs for permits and accompanying inspections and documentation shall be included in the Contractor's proposal.

1.12 OWNER TRAINING

- A. The Contractor shall provide (2) separate on the job training by a suitably qualified instructor(s), to personnel designated by the Owner, to instruct them in the operations, functions, and maintenance of the systems. In the event the Contractor does not have qualified instructors on staff for certain sophisticated equipment, a manufacturer's representative for such instruction will be provided by the Contractor at no additional cost to the Owner.
- B. All training shall take place after the systems are operational and accepted by the Owner. As AV systems are completed and the Owner assumes occupancy, the Contractor is also expected to provide training of AV systems as they are completed as well. A second training session is to occur approximately 30-days after the ignition training to address any questions or issues end-users have experienced with the A/V system during the first month of operation.
- C. Each of the (2) separate training sessions should including a minimum of two (2) 2-hour and one (1) 4-hour training sessions per room on the systems included in this specification. The 2-hour training sessions are intended for office staff to obtain the basic knowledge to operate the system. The 4-hour training sessions are intended for higher level technical instruction for the Owner's technical operations staff and is to include basic troubleshooting techniques. Each session is to accommodate up to 6 students. The Contractor is to provide a hard copy of the System Operation and Training Maintenance Manuals for each student. The Contractor is to leave a bound and laminated operations manual in each room.

1.13 CONTENTS OF CONTRACTOR'S PROPOSAL

A. Quality Assurances

1. CONTRACTOR QUALIFICATIONS: The Contractor shall be a firm with at least five years of experience in the fabrication, assembly, installation, and maintenance of Audiovisual systems of similar magnitude and quality as specified for this project.
 - a. The Contractor shall provide documentation that must identify a minimum of three (3) specific, similar projects of the same or greater magnitude within the past 5-years. Of those project descriptions submitted, the Contractor must provide current contact names and telephone numbers, as well as job description, with a clear delineation between labor and equipment costs, as well as duration of project. The descriptions supplied must clearly indicate that the firm submitting was actively involved in these projects and that the firm submitting has been actively involved for at least five years in projects of this magnitude.
 - b. The Contractor shall include copies of letters and/or certificates of proof of training certification by the following: industry certifications e.g. CTS, CTS-I, CTS-D, PMP, etc.
 - c. The Contractor shall include copies of Manufacturer Product Training/Certification for the products specified by the individuals who will be working on the project. Note: the individuals working on the project must hold certifications appropriate to their job function for the products specified on the project.
 - d. The Contractor shall include copies of letters and/or certificates from the OEM of proof of resale authorization for the products specified.
 - e. The Contractor shall provide resumes for the key project team including the project manager, design engineer, control system programmer, and installation supervisor.
 - f. The project manager shall have the following certifications:
 - 1) AVIXA CTS
 - 2) Project Management Professional PMP or Min. five years managing AV integrations of a similar scope and magnitude.
 - g. The design engineer shall have the following certifications:
 - 1) AVIXA CTS or CTS-D
 - h. The installation supervisor shall have the following certifications
 - 1) AVIXA CTS-I
 - i. The field engineer shall have the following certifications:
 - 1) AVIXA CTS
 - j. The programmer shall have the following certifications:
 - 1) AVIXA CTS
 - k. The Contractor shall have an office within 50 miles of the customer site staffed by qualified audiovisual field maintenance technicians capable of diagnosing and resolving system issues without the assistance of others.
 - l. Any field maintenance technician dispatched to the client site to troubleshooting the AV system shall have the following minimum qualifications:
 - 1) 3 years of experience in the audiovisual industry
 - 2) CTS certification
2. QUALITY OF MATERIALS AND EQUIPMENT: All materials and equipment supplied by the Contractor shall be new and shall meet or exceed the specified equipment in all respects. Refurbished or B stock equipment is not authorized. The Contractor shall supply the latest model, available at the time of bidding, of each piece of equipment. If applicable to this project, the Contractor shall evaluate all specified CFE items and notify the Owner and Consultant if those items are functionally deficient in any manner.

- B. Equipment Costs: The Contractor must provide detailed equipment lists with the submission of their proposal. Each piece of equipment shall be individually priced. Line item equipment costs shall reflect

all required modifications and accessories. Bidder shall be responsible for verification of all electronic costing formulas and to verify that itemized pricing and all total prices are accurate on each form, including a Bid Price Summary. Equipment totals from the equipment list shall be entered in a Bid Price Summary.

- C. **Engineering and Labor Costs:** Engineering and Labor Costs shall also be itemized on the Bid Price Forms. Engineering shall include, but is not limited to all required engineering services for design, drawings preparation, and preparation of any technical documentation. Labor shall include, but is not limited to, all preparation, fabrication, modification, assembly, rack wiring, and installation performed on the Contractor's premises and all installation, wiring, termination, coordination and supervision, testing, training, etc. performed on the Owner's premises. These costs shall include the labor costs for the first year preventive maintenance services.
- D. **General Conditions Costs:** General Conditions Costs shall include all general conditions costs, administrative costs, overhead expenses, profit, shipping, insurance, bonds, warranties and guarantees.
- E. **End User Software Licensing Agreement:** Include submission of Contractor's End User Software Licensing Agreement for review by the Owner. This document should assume that the Owner shall own all rights to edit, copy and distribute all Contractor authored programming, configurations, application, and documentation (drawings, O&M manuals, equipment lists, etc.) files for audiovisual control systems, network, audio digital signal processor, video signal processors, electronic annotation systems, content creation and content management systems, and any other applications specifically authored for the scope of this project. The Contractor shall provide the Owner with all files stored on three copies of a CD-ROM disk within 14 calendar days of room acceptance. Owner will review this document and negotiate final contents of this document with the Contractor.
- F. **Alternate Equipment**
 - 1. All bids shall be submitted on the basis of the specified equipment. The Bidder may propose alternate equipment, as a secondary proposal against the products specified herein. Alternate equipment is to include all required support systems that change as a result of the alternate. Submit your primary cost proposal using the equipment items specified and all "alternate" presented in a secondary cost proposal.
 - 2. Proposals for alternate equipment will receive careful and equitable consideration if the differences do not depart from the overall intent of the design and operation of the system, and are in the best interests of the Owner.
 - 3. Proposals for alternate equipment shall be accompanied by full technical information, cut sheets and specifications for the equipment so proposed. The Bidder shall identify the substantive differences between the alternate and the specified equipment.
- G. **Exceptions and Proposed Modifications**
 - 1. Should the Bidder have recommendations that will enhance the performance of the system, or reduce costs without loss of performance, such comments shall be made in the bid submission. All suggestions that are of value to the Owner will be taken into consideration in the evaluation of the bid returns. All such proposals shall be made as "alternates", with the appropriate cost modifications shown separate and apart from the costs of the system "as specified".
 - a. Any and all exceptions to these specifications and related drawings must be made with the bid submission. In the absence of exceptions, these specifications and related drawings shall be binding in letter and intent on the successful Bidder. It will further be assumed that the Bidder has examined the design and specifications in detail, and is

prepared to take full responsibility for the performance of the complete installation as designed and specified.

- H. Statement of Compliance: The bidder shall, with this response, submit a letter of compliance that clearly states his understanding as to the letter and intent of this specification. Failure to supply such statement with the bid response may be cause for disqualification.
- I. Schedule of Implementation
 - 1. The contractor should provide the Architect, Audiovisual Consultant and Owners project manager with the anticipated schedule of pertinent terminal dates after award of sub-contract for completion of design, pre-installation work, on-site installation work, testing and acceptance.
 - 2. The Contractor should also notify all parties of any equipment requiring anticipated long lead times, which may have a negative impact on the published schedule of completion.
 - 3. If the Contractor feels the proposed schedule is insufficient, that information shall be provided in your proposal submission. Changes or alterations of this schedule may result from the activities of other trades; the owner will make every effort to maintain these target dates with the full expectation the Contractor shall complete their work before occupancy. Your firm's participation in this project as a team member, expending every effort to ensure completion by the date provided regardless of changes and alterations, is expected.

PART 2 - PRODUCTS

2.1 GENERAL

- A. This narrative section of this specification defines the details of the audiovisual system to be supplied and installed.
- B. The naming of manufacturers and designations of specific products is for purposes of identifying and describing required functions and not to limit competition. Other manufacturers and models, capable of producing the same function, having the same quality, durability and performance, may be proposed for use on this project subject to the approval of the Owner's Representative.

2.2 OWNER FURNISHED EQUIPMENT

- A. With the exception of equipment cabinetry and furniture included in this specification, all room furniture and custom millwork will be furnished by the Owner.
- B. Equipment provided by the Owner will be designated in the specification and equipment list as Owner Furnished Equipment (OFE), Customer Furnished Equipment (CFE), or Government Furnished (GFE) on AV drawings in the AV specifications.

2.3 RELATED WORK SPECIFIED ELSEWHERE:

- A. The following systems and equipment are provided under other contracts:
 - 1. Task and general lighting systems, including special low voltage interfaces for remote control by AV equipment.
 - 2. All junction boxes, conduit, and floor boxes.

3. All furniture and millwork unless otherwise noted.
4. All electrical outlets and circuits.
5. All millwork cabinetry for integration with the Contractor provided equipment, unless otherwise described within this specification.
6. All electronic interfaces to building lighting, security and HVAC systems.
7. All IT network voice and data electronics and appliances, unless otherwise described within this specification.

2.4 SYSTEM FUNCTIONAL REQUIREMENTS

A. General Description:

B. The SI National Mall Carousel Site Improvements project includes a carousel audio system.

C. Carousel Audio System

1. CD / MEDIA PLAYER:

- a. Description: Professional CD / Media Player
- b. Acceptable Manufacturers:
 - 1) Denon
 - 2) Tascam
 - 3) Marantz
- c. Denon DN-500BDMKII, or approved equivalent
- d. Minimum Required Features and Specifications:
 - 1) Two (2) XLR Balanced Outputs
 - 2) Frequency Response : 20 Hz – 20 kHz
 - 3) One (1) 10/100 Mbps Ethernet Port for remote control from third-party control system over IP
 - 4) Plays compact Disc
 - 5) Front USB for media playback
 - 6) Front panel controls
 - 7) 1RU, includes rack mount ears
 - 8) Fast startup with Power-on-play

2. WIRELESS MICROPHONE SYSTEM:

- a. Description: Wireless Microphone Receiver
- b. Acceptable Manufacturers:
 - 1) Sennheiser
 - 2) Shure
 - 3) Audio Technica
- c. Sennheiser EW 300 G4-865-S-AS, or approved equivalent
- d. Minimum Required Features and Specifications:
 - 1) One (1) XLR Balanced Output
 - 2) Two (2) BNC Antenna Inputs

- 3) Frequency Response : 80 Hz – 18 kHz
 - 4) Range : 330 Feet
 - 5) Rack mounted
3. Wireless Microphone:
- a. Description: Wireless Condenser Microphone
 - b. Acceptable Manufacturers:
 - 1) Sennheiser
 - 2) Shure
 - 3) Audio Technica
 - c. Sennheiser MME 865-1 BK or approved equivalent
 - d. Sennheiser BA 2015G2 Rechargeable Battery (Provide two per microphone) or approved equivalent
 - e. Sennheiser L2015G2 Charging Station or approved equivalent
 - f. Minimum Required Features and Specifications:
 - 1) Polar Pattern: Supercardioid
 - 2) Supports two (2) AA Batteries or Sennheiser rechargeable battery
 - 3) Backlit Display
 - 4) Mute Switch
 - 5) 8-hr operation
 - 6) Metal Housing
 - 7) Sennheiser Rechargeable batteries per microphone, required optional accessory, sold separately.
 - 8) Two-port Sennheiser charging station, required optional accessory, sold separately.
4. DIGITAL SIGNAL PROCESSOR:
- a. Description: Analog / Network I/O Processor
 - b. Acceptable Manufacturers:
 - 1) Q-SYS
 - 2) BiAmp
 - c. Q-SYS Core 8 Flex, or approved equivalent
 - d. Minimum Required Features and Specifications:
 - 1) 64 Networked audio channels
 - 2) 8 Configurable Flex (audio input or output) channels
 - 3) 8 GPIO
 - 4) 8 AEC processor
 - 5) 8 x 8 Dante channels included
 - 6) 4 Channel recording
 - 7) 16 Channel playback
 - 8) 16 GB solid state drive (approximately 24-hours of audio storage)
 - 9) Dual LAN ports
 - 10) 1RU half-width rack mounting hardware included
 - 11) UCI Deployment Software License, Perpetual (Required, sold separately)
 - 12) Scripting Engine Software License, Perpetual (Required, sold separately)

5. AUDIO AMPLIFIER:
 - a. Description: 8 Channel Amplifier
 - b. Acceptable Manufacturers:
 - 1) Q-SYS
 - 2) JBL
 - 3) Crown
 - c. Q-SYS CX-Q4K8, or approved equivalent
 - d. Minimum Required Features and Specifications:
 - 1) Eight (8) Channel output
 - 2) 4,000W total power output assignable to eight channels, max 1000W per Channel
 - 3) Selectable Low impedance (2/4/8 Ohms), 70V, or 100V outputs
 - 4) Frequency response: 20 Hz - 20 kHz
 - 5) Eight (8) analog audio inputs
 - 6) 2 RU Rack ears mount included
 - 7) AVoIP IP input
 - 8) Dual LAN ports
 - 9) 100-240VAC input
6. OUTDOOR SPEAKER:
 - a. Description: 2-Way Speaker Outdoor
 - b. Acceptable Manufacturers:
 - 1) Q-SYS
 - 2) JBL
 - 3) Extron
 - c. Q-SYS AD-S10T, or approved equivalent
 - d. Minimum Required Features and Specifications:
 - 1) Two-way
 - 2) 10" woofer (or larger)
 - 3) 8 Direct impedance
 - 4) 50 Hz – 19 kHz frequency range
 - 5) Sensitivity: 92 dB SPL
 - 6) 250 Watts continuous, 500 Watts Max
 - 7) Terminal Connector with parallel output
 - 8) IP-54 protection
7. OUTDOOR SUBWOOFER:
 - a. Description: 10" Outdoor Subwoofer
 - b. Acceptable Manufacturers:
 - 1) Q-SYS
 - 2) JBL
 - 3) Extron
 - c. Q-SYS AD-S112sw, or approved equivalent

- d. Minimum Required Features and Specifications:
 - 1) 12" woofer (or larger)
 - 2) 8 Direct impedance
 - 3) 30 Hz – 135 Hz frequency range
 - 4) Sensitivity: 90 dB SPL
 - 5) 300 Watts continuous/ 600 Watts Max
 - 6) Terminal Connector with parallel output
 - 7) IP-54 protection

8. Network Switch:
 - a. Description: 10-Port AV Network Switch

 - b. Acceptable Manufacturers:
 - 1) Q-SYS

 - c. Q-SYS NS10-125+ or approved equivalent

 - d. Minimum Required Features and Specifications:
 - 1) (8) 10/100/1000 Mbps PoE+ (30W/port), 125W budget
 - 2) (2) SFP (1-Gbps)
 - 3) 24 Gbps Switching Fabric
 - 4) 1RU rack ears included

9. BRUSH PLATE:
 - a. Description: 1 RU Cable Pass Through Panel

 - b. Acceptable Manufacturers:
 - 1) Middle Atlantic

 - c. Middle Atlantic BR-1, or approved equivalent

 - d. Minimum Required Features and Specifications:
 - 1) 1 RU Rackmount
 - 2) Color: Black

10. TOUCH PANEL:
 - a. Description: 5" Touch Panel with Table Top Stand

 - b. Acceptable Manufacturers:
 - 1) Q-SYS

 - c. Q-SYS TSC-50-G3, or approved equivalent

 - d. Minimum Required Features and Specifications:
 - 1) 1280x720 Resolution
 - 2) 450 Nits brightness
 - 3) 802.3at Type 2, PoE+ (30W)
 - 4) Table Top Stand, required accessory, sold separately

11. FLOOR MOUNTED AV CABINET:
 - a. Description: 26RU Floor Mounted AV Cabinet/Rack

- b. Acceptable Manufacturers:
 - 1) NavePoint
 - c. NavePoint 00406919, or approved equivalent
 - d. Minimum Required Features and Specifications:
 - 1) 26 RU
 - 2) Max Rail Depth (Usable Depth): 19.28"
 - 3) Height: 54"
 - 4) Width: 25"
 - 5) Depth: 25"
 - 6) Rack Rails: EIA 19-standard square holes
 - 7) Fans: (2) with thermal sensor (120VAC 10A)
 - 8) Key Locking
 - 9) Protection Rating: IP56-Rated
 - 10) Heavy-duty 14 gauge cold-rolled steel
 - 11) White finish
 - 12) Pre-assembled
12. Power Strip:
- a. Description: 1 RU Horizontal Power Strip
 - b. Acceptable Manufacturers:
 - 1) Middle Atlantic
 - c. Middle Atlantic PD-915R, or approved equivalent
 - d. Minimum Required Features and Specifications:
 - 1) 1 RU Rackmount
 - 2) 120V/ 15 Amp
 - 3) (8) rear facing 5-15R receptacles
 - 4) (1) front facing 5-15R receptacle
 - 5) 9ft cord
 - 6) Color: Black

2.5 GENERAL

- A. Installation shall include the delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and all other work whether or not expressly required herein which is necessary to result in complete operational systems.
- B. All installation practices shall be in accordance with, but not limited to, the general design and construction requirements of the Owner, the general requirements of divisions 01 and 27 and all contract specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations of National, State, and Local authorities having jurisdiction. Before commencing work, the Contractor shall familiarize himself with all of these requirements.

- C. If, in the opinion of the Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a written request for modification shall be made to the Owner. Modifications shall not commence without written approval from the Owner.
- D. During the installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished work against damage and loss. In the event of such damage or loss, Contractor shall replace or repair such work at no cost to the Owner.

2.6 SYSTEM INTERCONNECTIONS

- A. The functional interconnections of the audio, video systems shall be as detailed on the drawings.
- B. The Contractor shall provide all interconnection cable, connectors, terminal strips, Patch panels, faceplates, wireway, flexible conduit, etc., to facilitate the audiovisual systems as detailed within these specifications and drawings.
- C. The conduit and power system are detailed in the Electrical Engineer's drawings.
- D. The telecommunications wiring and network is detailed on the Telecommunications Engineer's drawings.
- E. Details for special mounting conditions and millwork design are detailed on the Architect's drawings.

2.7 SHOP DRAWING REQUIREMENTS

- A. Equipment blocks shall include the following information:
- B. Unique device name (E.G. SPK.C1400.01)
- C. Every device to be installed
- D. Inputs (destinations) are shown on the left side of the equipment block.
- E. Outputs (sources) are shown on the right side of the equipment block.
- F. Bi-direction ports, such as serial control or Ethernet, can be shown on either side of the block with the following exceptions.
 - 1. Uplink ports on network switches are always shown on the left side of the equipment block.
 - 2. Access ports on network switches are always shown on the right side of the equipment block.
 - 3. Network ports on access devices (computers, touch panels, etc.) are always shown on the left side of the equipment block.
 - 4. The serial port on a controller device, such as an AV central controllers or wall plates with integrated controller, is always shown on the right side of equipment block.
 - 5. The serial port on a controlled device, such as a display, projector, VTC codec, DSP, is always shown on the left side of the equipment block.
- G. While the inputs and outputs (Video, audio, control, and data) connectors on a specific device may be spread across multiple drawings, the same physical connector cannot be shown more than once in the drawing package for a specific device.

- A. Cable feathers or flags that connect devices on different drawings require the unique system name/device identifier and port information the cable connects to on the opposite device and the drawing number of the opposite feather/flag.
- B. Cable feathers or flags that connect devices on the same drawings do not require the drawing number of the opposite feather/flag; however, the unique system name/device identifier and port of opposite device is required.

2.8 EQUIPMENT LAYOUT

- A. The equipment and infrastructure to support the equipment for each area shall be detailed on the drawings.
- B. Label all racks and credenzas, front and rear, with rack/credenza number using plastic label

2.9 PHYSICAL INSTALLATION:

- A. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise. Fastenings and supports shall be adequate to support their loads with a safety factor of at least five. All boxes, equipment, etc., shall be secured plumb and square. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
- B. All access covers not completely removable shall be self-supporting in the open position.
- C. Label all rack mounted equipment, front and rear, with unique device name.
- D. Label all equipment mounted behind displays or under tables/desks with unique device name.
- E. Label rear of displays with unique device name.
- F. Do not label front of user/audience facing devices with unique device name. Instead, label these devices such that they are visible for maintenance, but out of audience view.

2.10 CABLE INSTALLATION

- A. All cables, regardless of length, shall be marked with a wrap-around cable label at both ends. All cable labels are to include a unique cable number, source equipment unique name and port information, and destination equipment unique name and port information. There shall be no unmarked cables at any place in the system. Text on all cable labels shall correspond with the line drawings and cable run sheets. Cable label standards and material must be approved by the Owner and AV Consultant prior to installation. All labels are to be computer generated using either laser or thermal generated printers. No hand-written labels will be accepted and must be replaced prior to the testing and acceptance of the room. All inter-rack cabling shall be neatly strapped, dressed, and adequately supported.
- B. Terminal blocks, boards, strips, or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules. This includes all copper and fiber tie cables that connect the TR to the A/V racks, credenzas, and lecterns inside the A/V rooms.

- C. No audio cables shall be terminated directly to the audio patch panel jacks. Each audio patch panel shall be furnished with an audio terminal block and all audio cables to and from the audio patch panel shall terminate on this block.
- D. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cables:
 - 1. Electrical power
 - 2. Control & Data Networking
 - 3. Video
 - 4. Audio
- E. As a general practice, all power cables, control cables and high-level cables shall be run on the left side of an equipment rack as viewed from the rear. All other cables shall be run on the right side of an equipment rack, as viewed from the rear.

For this project, the Owner requires the Contractor to use plenum-rated cables where home run conduits are NOT provided for the audiovisual system or above finished ceilings. Unless otherwise called for in these specifications and drawings, the following cables, or their approved riser equivalents, shall be used in these systems:

Signal Type	Color	Option 1	Option 2
Audio (MIC/LINE)	Black	Belden 9451P	West Penn D25454
RS232/contact closure	Red	Belden 9451P	West Penn D25454
Speaker runs up to 300ft	Natural/White	Belden 6200UE	West Penn 25225B
Speaker rungs longer than 300ft	Natural/White	Belden 6100UE	West Penn 25226B
CATV/MATV (75 Ohm)	White	Belden 1189AP	West Penn 256300
Crestron DM	Blue	CRESTRON DM-CBL-ULTRA-P	
HDBASE-T	Blue	Belden 10GX63F	West Penn 254246AF
Conference Microphone	Blue	Belden 10GX63F	West Penn 254246AF
CAT6A (STP)	Blue	Belden 10GX63F	West Penn 254246AF
CAT6/CAT6A (UTP)	Black (Use different colors than Telecom contractor.)	Use same cable as Telecom contractor. See 271500 specs	Use same cable as Telecom contractor. See 271500 specs contractor in 271500 specs
HDMI/DVI/DISPLAYPORT	Black	Extron Ultra Series	

- F. All AV Contractor terminated cables shall be cut to the length dictated by the run. The appropriate length premade cables, such as HDMI and USB, should be used as excessive extra cable is not acceptable to the Owner. No splices or couplers shall be permitted in any pull boxes without prior written permission of the Owner. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.
- G. All Network/data copper cabling shall be 4-pair, UTP, plenum rated CAT-6A cable unless otherwise noted. All CAT-6A cables shall be terminated on CAT-6A rated RJ-45 connector and/or jacks.
- H. Provide certification documentation that the Contractor has tested their installed wiring and connectivity per industry standards, specifically telecommunications cabling e.g. Category 6A UTP and optical fiber cabling. This certification documentation shall include all cables listed on the drawings and/or cable run list.
- I. Fiber, coax, and Category cables shall be neatly dressed using Velcro (Hook and loop). Using nylon wire ties is prohibited.
- J. Audio, speaker, and serial control cables shall be neatly dressed using Velcro (Hook and Loop) or nylon wire ties.
- K. All 1.8 (3.5 mm) stereo audio cables shall be factory premade (not field terminated) to the greatest extent possible.
- L. Terminate all HDBASE-T/DM 8G cables using connectors and crimping tool from the cabling manufacturer.

2.11 CONNECTION PLATE RECEPTACLES:

- A. Unless otherwise detailed herein, the following types of panel receptacles shall be used on all connection boxes, panels, plates, and wireways:
- B. Video - BNC type. Wall plate inputs and outputs shall be female connectors. Portable cabling shall include male connectors at each end and shall be rated for 3 Gbps.
- C. Control RS232 - SubD9 type. Wall plate inputs and outputs shall be female connectors. Portable cabling shall include male connectors at each end. RS232 signal cables to be kept to 50 ft or less.
- D. DVI. Wall plate connectors shall always be female. Cabling shall be male connectors on each end.
- E. HDMI. Wall plate connectors shall always be female. Cabling shall be male connectors on each end.
- F. DISPLAYPORT. Wall plate connectors shall always be female. Cabling shall be male connectors on each end.

2.12 PATCH PANELS

- A. Assignments: All patch panels shall be wired so that signal "sources" (outputs from) appear on the upper row of a row pair; and all "loads" (inputs to) appear on the lower row of a row pair.

- B. Patch Panel Designation Strips: All audio and video patch panel designation strips shall utilize alphanumeric identifications and descriptive information. The jack position in each horizontal row shall be numbered sequentially from left to right. The horizontal jack rows shall be lettered sequentially from top to bottom. The alphanumeric identification of each jack shall be included on the functional block drawings, as well as on reproductions of these drawings, which shall be mounted in an appropriate location near the patch bays. All patch panel labels shall be printed on card stock using a laser printer. No hand-written labels are acceptable to the Owner and must be replaced prior to Testing and Acceptance.

2.13 GROUNDING PROCEDURES

- A. In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:
 1. System Grounds: A single primary "system ground" shall be established for the systems in each particular area. All grounding conductors in that area shall connect to this primary system ground. The system ground shall be provided in the audio equipment rack for the area and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors. A copper conductor, having a maximum of 0.1 Ohms total resistance, shall connect the primary system ground bar to the nearest metallic electrical conduit of at least 5.08 cm (2 in) in diameter. The Contractor shall be responsible for determining if the metallic conduit is properly electrically bonded to the building ground system.
 2. Secondary System Grounding Conductors shall be provided from all racks, audio consoles and ungrounded audio equipment in each area, to the primary system grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground.
 3. Audio Cable Shields: All balanced audio cables shall be shielded and shall be grounded at only one point, the signal "source" (output from) connector. The ground is to be lifted (not connected) at the signal "load" (input to) connector. For unbalanced audio cables, the shield is to be connected to the ground at the signal "source" (output from) connector and lifted at the signal "load" (input to) connector. The shield is to be connected at both ends for microphone level signals. Unbalanced audio signals are susceptible to noise and shall be kept to 6.096 m (20 ft) or less.
 4. Video Receptacles: All video receptacles that are provided and installed by the Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated from panel type receptacles.
 5. General: Because of the great number of possible variations in grounding systems, it shall be the responsibility of the Contractor to follow good engineering practice as outlined by EIA/TIA and recommended by BICSI and AVIXA. Deviation from these practices is permitted only when necessary to minimize crosstalk and to maximize signal to noise ratios in the audio, video, and control systems.

2.14 PERFORMANCE TEST SIGNAL PATHS:

- A. Test all signal paths for the above Performance Standards shall be as follows:
- B. Audio: From all source inputs (for microphones, audio tape units, video tape units, etc.) through all mixers, ADA's, switchers, etc., to all signal destinations.
- C. Video: From all source inputs, through all processors, switchers, etc., to all signal destinations.

- D. The delineation of the above signal paths shall not exempt the Contractor from the responsibility of checking all paths and outlets for appropriate compliance with the Performance Standards.

2.15 CONTRACTOR SYSTEM CHECKOUT

- A. Before Acceptance Tests are scheduled, the Contractor shall perform his own system checkout. He shall furnish all required test equipment and shall perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification. This test and commissioning procedure shall be fully documented and include the following:
 - B. Test all audio and video systems for compliance with the Performance Standards.
 - C. Check all control functions, from all controlling devices to all controlled devices, for proper operation.
 - D. Adjust, balance and align all equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for all level controls and record these settings in the "System Operation and Maintenance Manual."
 1. Check all optical projection images for average light level, light fall off, image alignment and size to comply with the Performance Standards and specification drawings. Check to determine that all projectors, projector bases, carts, tables and mirrors are rigid and vibration-less in operation.
 2. Maintain documentation of all performance tests for reference by the Owner during the System Acceptance Tests.

2.16 SYSTEM ACCEPTANCE TESTS

- A. Prior to Owner Acceptance, the Contractor is responsible for demonstrating that the entire scope of work defined is complete and fully functional per the scope of this specification and drawings, as well as any additional approved Change Order directives.
- B. Prior to conducting the Proof of Performance for the benefit of the Owner and the Owner's representatives, the Contractor must complete their own quality review and complete all system commissioning and programming procedures. The Contractor must also provide a red-lined set of drawings and documentation.
- C. For the Proof of Performance (Acceptance Test Procedure), the Contractor is responsible for notifying the General Contractor and Owner at least two weeks in advance of a scheduled session. At least one week prior to the Testing and Acceptance, the AV Contractor is to provide the Test Plan for review and approval of the Owner and AV Contractor. At time of Proof of Performance session, the Contractor is responsible for providing all test equipment and test materials (blank & pre-recorded video tape, blank and prerecorded audio tape, Audio CD, high resolution test signal generators, etc.). The System Acceptance Tests will be supervised by the Owner and AV Consultant and will consist of the following:
 1. A physical inventory of all equipment on site will be taken and will be compared to equipment lists in the contract documents. This physical inventory must be provided to the Owner, in advance of the scheduled Acceptance Test Procedure, in electronic spreadsheet format using Microsoft Excel software application.
 2. The Contractor shall document and report the results of all testing data. The testing data shall be provided to the Owner and certified by the Contractor.

3. The operation of all system equipment shall be demonstrated by the Contractor.
 4. Both subjective and objective tests will be required by the Owner to determine compliance with the specifications. The Contractor shall be responsible for providing test equipment for these tests.
 5. All “red-line” shop drawings, run sheets, manuals, and other required documents shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time.
 6. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Owner.
- D. Programming (Minimum requirements)
1. RIP and load audio CD provided by Owner onto DSP’s internal media storage.
 2. Configured DSP to play audio on internal media player upon receiving “Play” contact closure on DSP’s GPIO from Carousel operator station.
 3. Configured DSP to stop audio on internal media player upon receiving “Stop” contact closure on DSP’s GPIO from Carousel operator station.
 4. Configured speakers in DSP based on speakers selected.
 5. Configured DSP to duck audio from either internal media player or external CD/media player when audio is detected on the microphone.
 6. Touch panel GUI
 - a. Master volume up, down, and mute
 - b. CD player
 - 1) Volume up, down, and mute
 - 2) Source select (CD, USB, SD card)
 - 3) CD play, stop, pause, next, previous, fast-forward, rewind, etc. commands.
 - 4) USB media play, stop, pause, next, previous, fast-forward, rewind, etc. commands.
 - 5) SD card play, stop, pause, next, previous, fast-forward, rewind, etc. commands.
 - c. DSP’s internal media player play, stop, loop/repeat, and pause commands
 - d. Admin page with password
 - 1) Microphone volume up, down, and mute
 - 2) Speaker one volume up, down, and mute
 - 3) Speaker two volume up, down, and mute
 - 4) Speaker three volume up, down, and mute
 - 5) Speaker four volume up, down, and mute
 - 6) Subwoofer one volume up, down, and mute
 - 7) Subwoofer two volume up, down, and mute

END OF SECTION 274116

SECTION 280500.10 – COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide the electronic security system (ESS) in accordance with the drawings, specifications, and referenced publications.
- B. Perform all work, products, systems integration, engineering, and design work required for the project in order to ensure complete and fully operational systems and proper installation of equipment. Provide calculations and analysis to support design and engineering decisions as specified in submittals. Provide and pay all labor, materials, and equipment, sales and gross receipts and other taxes. Secure and pay for plan check fees, permits, other fees, and licenses necessary for the execution of work as applicable for the project. Give required notices; comply with codes, ordinances, regulations, and other legal requirements of public authorities, which bear on the performance of work.
- C. Provide an ESS, installed, programmed, configured, documented, and tested. The security system includes but is not limited to: access control, intrusion detection, duress alarms, elevator control interface, video surveillance and assessment, video recording and storage, delayed egress, intercommunication system, fire alarm interface, equipment cabinetry, and uninterruptible power supplies (UPS) interface.
- D. The work includes the procurement and installation of electrical wire and cables, the installation and testing of all system components. Inspection, testing, demonstration, and acceptance of equipment, software, materials, installation, documentation, and workmanship shall be as specified herein. Provide all associated installation support, including the provision of primary electrical input power circuits.
- E. Provide repair service replacement parts and on-site service during the warranty period. Guarantee all parts and labor for a term of one (1) year, unless dictated otherwise in this specification from the acceptance date of the system as described in specification 280800.10. The Contractor is responsible for all equipment, software, firmware, licensing, shipping, transportation charges, and expenses associated with the service of the system for one (1) year.
- F. Operator training is not required.

1.2 SUMMARY

- A. This specification provides general requirements for the overall electronic security system (ESS) applicable to all projects.

1.3 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. This Specification is the base document for electronic security systems. Use the following specification sections in conjunction to provide a complete and fully integrated security management system.
1. 26 0526 – Grounding and Bonding for Electrical Systems
 2. 27 1116.10 – Security Cabinets, Racks, Frames, and Enclosures
 3. 27 1300.10 – Security Backbone Cabling
 4. 27 1500.10 – Security Horizontal Cabling
 5. 28 0500.10 – Common Work Results for Electronic Security
 6. 28 0509.10– Surge Protection for Electronic Security
 7. 28 0513.10 – Servers, Workstations and Storage for Electronic Security
 8. 28 0531.10 – Communications Equipment for Electronic Security
 9. 28 0800.10 – Commissioning of Electronic Security
 10. 28 2000 – Video
 11. 28 3100 – Intrusion Detection
- C. Requirements of Specification 280500.10 take precedence over Division 01 System Acceptance requirements.
- D. Related Sections include the following:
1. Division 01
 2. Division 08
 - a. Coordinate Division 8 and 28 requirements.
 3. Division 12
 - a. Coordinate case mounted security sensors and equipment.
 4. Division 26
 - a. Provide dedicated Emergency Electrical Power (120 VAC) circuits as required to provide full system functionality.
 5. Division 27
 - a. Shared pathways
 - b. Security Cabling
 - c. Grounding and Bonding System

1.4 REFERENCES

- A. American National Standards Institute (ANSI)
1. ANSI INCITS 92 (1980, R 2003), Data Encryption Standard
 2. ANSI/TIA-568.0-D, Rev D (9/2015+Edit:12/2015) , Generic Telecommunications Cabling for Customer Premises
 3. ANSI/TIA-568.1-D, Rev D (9/2015), Commercial Building Telecommunications Infrastructure Standard
 4. ANSI/TIA-568-C.2, Rev C (8/2009+A1:6/2016), Balanced Twisted-Pair Telecommunications Cabling And Components Standards
 5. ANSI/TIA-568-C.3, Rev C (6/2008+A1:10/2011), Optical Fiber Cabling Components Standard
 6. ANSI/TIA-568-C.4, Rev C (7/2011), Broadband Coaxial Cabling and Components Standard
 7. ANSI/TIA-569, REV D (4/2015), Telecommunications Pathways and Spaces

8. ANSI/TIA-606, Rev B (6/2012+A1:12/2015), Administration Standard for the Telecommunications Infrastructure
 9. ANSI/TIA-607, Rev C (11/2015), Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 10. ANSI/TIA/EIA 492AAAB Rev B (11/2009), Detail Specification for 50µm Core Diameter / 125µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
 11. ANSI/TIA/EIA-526-14 Revision C (4/2015), Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement
 12. ANSI/SIA CP-01-2014, Control Panel Standard - Features for False Alarm Reduction
- B. ASTM International (ASTM)
1. ASTM A153/A153M-16, Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 2. ASTM B3-13, Standard Specification for Soft or Annealed Copper Wire
 3. ASTM B32-08 (2014), Standard Specification for Solder Metal
 4. ASTM C1107/C1107M-14a, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 5. ASTM D709-16, Standard Specification for Laminated Thermosetting Materials
 6. ASTM E84-16, Standard Test Method for Surface Burning Characteristics of Building Materials
- C. Federal Information Processing Standards (FIPS):
1. FIPS PUB 201 2nd Edition (8/1/2013), Personal Identity Verification (PIV) of Federal Employees and Contractors
- D. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE Std 100 (2000), The Authoritative Dictionary of IEEE Standards Terms
 2. IEEE 81, 2012 Edition (12/2012), Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
 3. IEEE 142, 2007 Edition (11/2007), Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book (Color Book Series)
 4. IEEE C2 National Electrical Safety Code (NESC), 2017 Edition
 5. IEEE C62.41.1, 2002 Edition (11/2002), RN: (12/2008), Guide on Surges Environment in Low Voltage (1000 V and Less) AC Power Circuits
 6. IEEE C62.41.2, 2002 Edition (11/2002), CRGD: (12/2012), Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- E. International Organization for Standardization (ISO)
1. ISO 7810, 2003 Edition, A2 (01/2012), Identification Cards – Physical Characteristics
- F. National Electrical Contractors Association (NECA)
1. NECA 1 2015 Edition (1-2015), Standard for Good Workmanship in Electrical Construction
- G. National Electrical Manufacturers Association (NEMA)

1. NEMA 250, 2014 Edition (1/2014), Enclosures for Electrical Equipment (1000 Volts Maximum)
 2. NEMA ICS 1 (2000; R 2015), Industrial Control and Systems: General Requirements
 3. NEMA ICS 2 (2000; Errata 3/2008), Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated 600 Volts
 4. NEMA ICS 6 93rd Edition (1993; R 2011), Industrial Control and Systems: Enclosures
- H. National Fire Protection Association (NFPA)
1. NFPA 70 2020 Edition (2023), National Electrical Code
 2. NFPA 72 2019 Edition (2019), National Fire Alarm and Signaling Code.
 3. NFPA 101 2021 Edition (2021), Life Safety Code
 4. NFPA 262 2019 Edition (2019), Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
 5. NFPA 730 2020 Edition (1/2020), Guide for Premises Security
 6. NFPA 731 2020 Edition (1/2020), Standard for the Installation of Electronic Premises Security Systems
- I. Security Industry Association (SIA)
1. SIA BIO-01-1993.02 (R2000.06), Biometric Vocabulary Standard
 2. SIA DC-01-1988 (R2001.04), DCS Computer Interface (CIS-1) Technical Report
 3. SIA DC-03-1990.01 (R2003.10), DCS SIA Format Standard
 4. SIA DC-07-2001.04, DCS Computer Interface (CIS-2) Standard
- J. Telecommunications Industries Association (TIA)
1. TIA-232 Rev F (10/1997; R 12/2012), Interface Between Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary data Exchange
 2. EIA/ECA-319 Rev E (12/2005), Cabinets, Racks, Panels, and Associated Equipment
 3. TIA-455-3, Rev B (7/2009), Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components
 4. TIA-455, Rev C (8/2014), General Requirements for Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
 5. TIA-598 Revision D (7/2014), Optical Fiber Cable Color Coding
 6. TIA-604-3 Revision B (8/2004; R 1/2014), FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC
 7. TIA-604-1 1996 Edition (3/1996; R 1/2012), Fiber Optic Connector Intermateability Standard
- K. Underwriters Laboratories (UL)
1. UL 6 2014 Edition (11/2014), Electrical Rigid Metal Conduit - Steel
 2. UL 50 13th Edition (10/2015), Enclosures for Electrical Equipment, Non-Environmental Considerations
 3. UL 50E 2nd Edition (10/2015), Enclosures for Electrical Equipment, Environmental Considerations
 4. UL 83 15th Edition (3/2014), Thermoplastic-Insulated Wires and Cables
 5. UL 294 6th Edition (2/2015), Access Control System Units
 6. UL 444 4th Edition (4/2015), Communications Cables

7. UL 464 10th Edition (1/2016), Audible Signaling Devices for Fire Alarm and Signaling Systems, including Accessories
8. UL 467 10th Edition (3/2013), Standard for Safety Grounding and Bonding Equipment
9. UL 497B 4th Edition (12/2012), Protectors for Data Communication and Fire Alarm Circuits
10. UL 609 11th Edition (3/2015), Local Burglar Alarm Units and Systems
11. UL 634 2009 Edition (12/2009; R 3/2015), Connectors and Switches for Use with Burglar-Alarm Systems
12. UL 636 10th Edition (10/2008; R 1/2013), Holdup Alarm Units and Systems
13. UL 639 8th Edition (5/2012), Intrusion Detection Units
14. UL 681 15th Edition (1/2014), Installation and Classification of Burglar and Holdup Alarm Systems
15. UL 796 11th Edition (5/2016), Printed-Wiring Boards
16. UL 797 9th Edition (12/2012), Electrical Metallic Tubing -- Steel
17. UL 827 8th Edition (2/2015), Central Station Alarm Services
18. UL 910 5th Edition (11/1998), Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
19. UL 969 4th Edition (11/2001), Marking and Labeling Systems
20. UL 972 6th Edition (7/2011), Burglary Resisting Glazing Material
21. UL 1037 6th Edition (9/2016), Antitheft Alarms and Devices
22. UL 1076 5th Edition (3/2015), Proprietary Burglar Alarm Units and Systems
23. UL 1424 4th Edition (1/2015), Power-Limited Fire-Alarm Circuits
24. UL 1492 (3/2002; R 7/2013), Audio-Video Products and Accessories
25. UL 1581 4th Edition (8/2016), Reference Standard for Electrical Wires, Cables, and Flexible Cords
26. UL 1610 4th Edition (7/2016), Central-Station Burglar-Alarm Units
27. UL 1635 3rd Edition (1/2012; R 3/2015), Digital Alarm Communicator System Units
28. UL 1638 5th Edition (1/2016), Visible Signaling Devices for Fire Alarm and Signaling Systems, including Accessories
29. UL 1638A 1st Edition (6/2016), Visual Signaling Appliances for General Signaling Use
30. UL 1655 2nd Edition (11/2014; R 11/2014), Community-Antenna Television Cables
31. UL 1660 5th Edition (7/2014), Liquid-Tight Flexible Nonmetallic Conduit
32. UL 1666 5th Edition (6/2012), Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
33. UL 1981 3rd Edition (4/2015), Central Station Automation Systems
34. UL 2050 5th Edition (11/2010), National Industrial Security Systems
35. UL 2196 1st Edition (3/2012), Tests for Fire Resistive Cables

1.5 DEFINITIONS

- A. ARA: Area of Rescue Assistance
- B. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- C. BICSI: Building Industry Consulting Service International
- D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.
- E. CPU: Central processing unit.

- F. Credential: Data assigned to an entity and used to identify that entity.
- G. DGP: Data Gathering Panel
- H. EMI: Electromagnetic interference.
- I. EMT: Electric Metallic Tubing
- J. ESS: Electronic Security System
- K. GFI: Ground fault interrupter.
- L. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- M. I/O: Input/Output.
- N. INC: Intelligent Network Controller
- O. Intrusion Zone (IZ): A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.
- P. LAN: Local area network.
- Q. LCD: Liquid-crystal display.
- R. LED: Light-emitting diode.
- S. LOD: Level of Detail
- T. LOE: Level of Effort
- U. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- V. M-JPEG: Motion – Joint Photographic Experts Group.
- W. MPEG: Moving picture experts group.
- X. NEC: National Electrical Code
- Y. NECA: National Electrical Contractors Association
- Z. NEMA: National Electrical Manufacturers Association
- AA. NFPA: National Fire Protection Association
- BB. NRTL: Nationally Recognized Testing Laboratory.

- CC. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- DD. OPS: Office of Protection Services
- EE. OTDR: Optical Time Domain Reflectometer
- FF. PACS: Physical Access Control System
- GG. PIR: Passive infrared
- HH. PIR Rex: Passive Infrared Request to Exit
- II. PPSD: Personnel and Physical Security Division (A department within OPS)
- JJ. RCDD: Registered Communications Distribution Designer.
- KK. RF: Radio frequency.
- LL. RFI: Radio-frequency interference.
- MM. RIGID: Rigid conduit is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
- NN. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- OO. RS-485: An TIA/EIA standard for multipoint communications.
- PP. SMS: Security Management System – A SMS is a software that incorporates multiple security subsystems (e.g., access control, intrusion detection, closed circuit television, intercom) into a single platform and graphical user interface.
- QQ. Standard Intruder: A person who weighs 100 lb. (45 kg) or more and whose height is 1525 mm (60 in) or more; dressed in standard clothing.
- RR. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- SS. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- TT. TDMM: Telecommunications Distribution Methods Manual
- UU. TIA: Telecommunications Industry Association
- VV. UPS: Uninterruptible Power Supply
- WW. UTP: Unshielded Twisted Pair
- XX. VASS: Video Assessment and Surveillance System

YY. VPN: Virtual Private Network

ZZ. WAN: Wide Area Network.

AAA. WAV: The digital audio format used in Microsoft Windows.

BBB. Windows: Operating system by Microsoft Corporation.

CCC. Workstation: A PC with software that is configured for specific limited security system functions.

DDD. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

1.6 GENERAL ARRANGEMENT OF CONTRACT DOCUMENTS

- A. The Contract Documents supplement to this specification indicates approximate locations of equipment. The installation and/or locations of the equipment and devices shall be governed by the intent of the design; specification and Contract Documents, with due regard to actual site conditions, recommendations, ambient factors affecting the equipment and operations in the vicinity. The Contract Documents are diagrammatic and do not reveal all offsets, bends, elbows, components, materials, and other specific elements that may be required for proper installation. If any departure from the contract documents is deemed necessary, or in the event of conflicts, the submit details of such departures or conflicts in writing to the owner or owner's representative for his or her comment and/or approval before initiating work.
- B. Anything called for by one of the Contract Documents and not called for by the others shall be of like effect as if required or called by all, except if a provision clearly designed to negate or alter a provision contained in one or more of the other Contract Documents shall have the intended effect. In the event of conflicts among the Contract Documents, the Contract Documents shall take precedence in the following order: the Form of Agreement; the Supplemental General Conditions; the Special Conditions; the Specifications with attachments; and the drawings.

1.7 SUBMITTALS

A. General

1. Comply with the Contract Documents and in accordance with this section. Submittals lacking the breadth or depth of these requirements will be considered incomplete and rejected. Submissions are considered multidisciplinary and require coordination with applicable divisions to provide a complete and comprehensive submission package. Additional general provisions are as follows:
 - a. Schedule submittals to maintain the project schedule. For coordination drawings refer to Division 1 Specification, which outline basic submittal requirements and coordination.
 - b. Identify variations from requirements of Contract Documents and state product and system limitations, which may be detrimental to successful performance of the completed work or system.
 - c. Submit each package at one (1) time for each review and include components from applicable disciplines (e.g., electrical work, architectural finishes, door hardware, etc.) which are required to produce an accurate and detailed depiction of the project.

- d. Manufacturer's information used for submittal shall have pages with items for approval tagged, items on pages shall be identified, and capacities and performance parameters for review shall be clearly marked through use of an arrow or highlighting. Provide space for COTR and Contractor review stamps.
- e. Drawings shall be in the project specific version of AutoCAD® or REVIT, drawn accurately, and in accordance with Smithsonian Institution CAD and REVIT Standards. FREEHAND SKETCHES OR COPIED VERSIONS OF THE CONSTRUCTION DOCUMENTS WILL NOT BE ACCEPTED. If departures from the drawings are subsequently deemed necessary by the Contractor, submit details of such departures and the reasons thereof in writing to the COTR and the PPSD Security Engineer for approval before initiating work.
- f. Submittal Format
 - 1) Provide one (1) hard-copy of drawings. Make all other submittals as PDF with bookmarks for sections.
 - 2) Refer to SI Special Conditions Document for drawing format and content requirements.

B. Pre-Installation Submittals

- 1. Qualifications
 - a. The Security Contractor is not allowed on-site until the Owner approves the Qualifications submittal.
 - b. Provide Company certifications
 - 1) Software House
 - a) [Certified Integrator][Advanced Integrator][Enterprise Partner]
 - c. Include qualifications and manufacturer's certifications for individuals working on the project including but not limited to:
 - 1) Software House
 - a) CCURE 9000
 - 2) American Dynamics
 - a) Victor
 - b) Video Edge
 - 3) Vingtor-Stentofon
 - 4) Cisco
 - a) [Cisco Certified Network Associate (CCNA)][Cisco Certified Network Professional (CCNP)]
 - 5) BICSI
 - a) RCDD
 - d. Provide project references as outlined in Paragraph 1.11 A "Contractor Qualifications".
- 2. Product Data
 - a. Provide a chart of product data listing the specification section and paragraph number of each product. Annotate if "Provided as Specified" or "Substitution Requested".
 - b. Product data sheets organized and bookmarked by Specification Division. Annotate deviations from the design documents and the justification for the change.
 - c. Where the words, "or approved equivalent" or like words are used, either furnish the equipment as specified or submit a request for substitution in writing with the make, model, and justification to the COTR and the PPSD Security Engineer for approval.
 - d. If the contractor recommends equipment substitution, the contractor is responsible for complete documentation of the reason for the change including price differential and is financially liable for the design time expended by the security consultant to research the substitution.

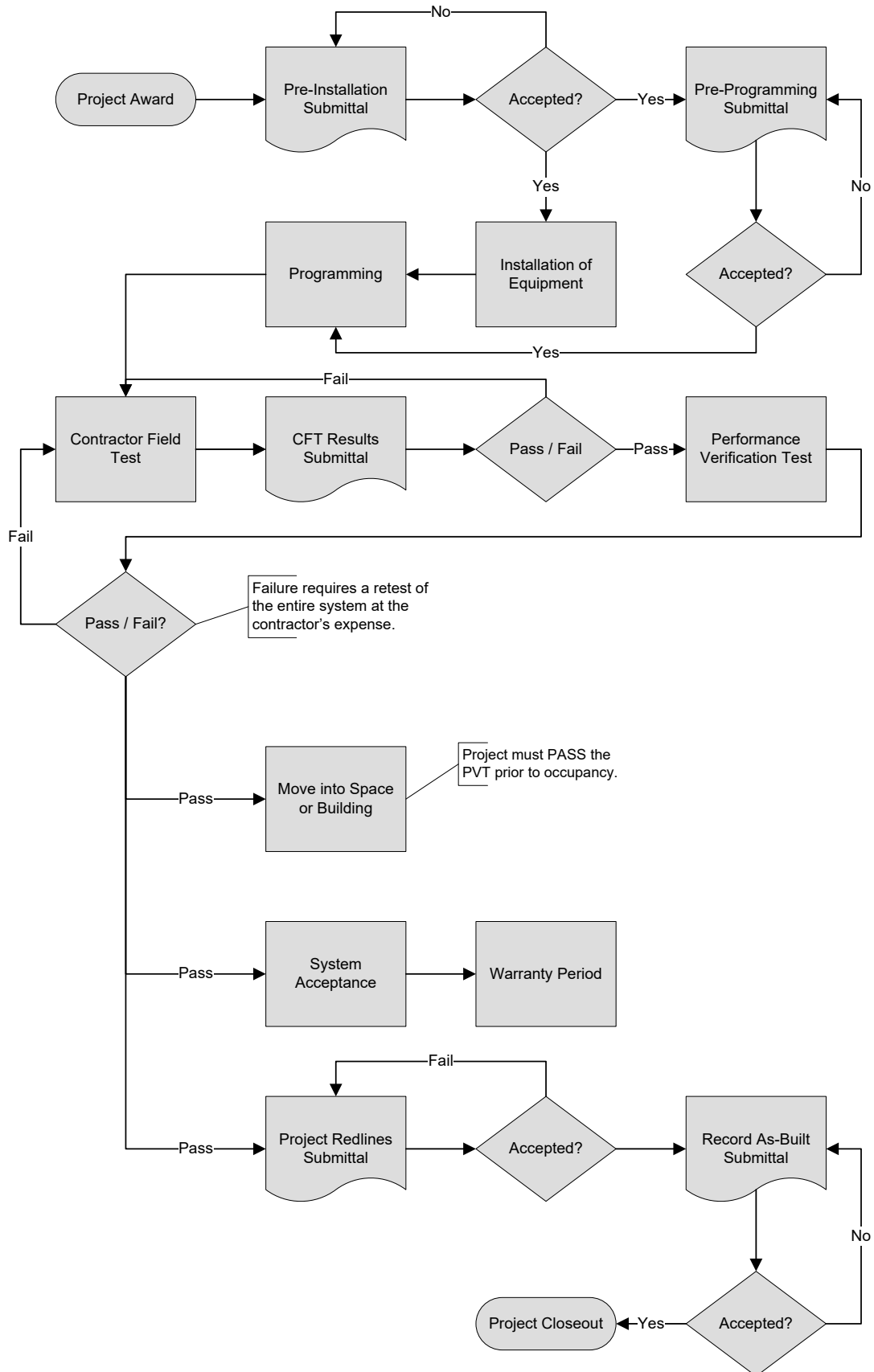
3. Shop Drawings
 - a. Build upon the design documents to reflect current conditions and approved product data. Annotate deviations from the design documents and the justification for the change.
 - b. Include wiring diagrams to include but not limited to power supplies, card readers, fire alarm connections, elevator interface, and tamper circuits.
 - c. Security door schedule coordinated with Division 8 requirements. Include the following information:
 - 1) Configuration Number
 - 2) Door Number (Derived from Architectural Drawings)
 - 3) Floor Plan Sheet Number
 - 4) Standard Detail Number
 - 5) Door Description (Derived from Loading Sheets)
 - 6) Security Point Number (Derived from Loading Sheets)
 - 7) Door Position or Monitoring Device Type, Make & Model Number
 - 8) Lock Type, Model Number & Power Input/Draw (standby/active)
 - 9) Card Reader Type, Make & Model Number
 - 10) Shunting Device Type, Make & Model Number
 - 11) Sounder Type, Make & Model Number
 - 12) Camera Make & Model Number
 - 13) Misc. devices as required
 - a) Delayed Egress Type, Make & Model Number
 - b) Intercom Make & Model Number
 - c) Electric Transfer Hinge
 - d) Electric Pass-through device
 - 14) Remarks column indicating special notes or door configurations
- C. Pre-Programming Submittals
 1. Nameplates
 2. IP Addressing Scheme
 - a. Provide OPS with the quantity of devices requiring IP addresses. OPS will then provide the IP addressing scheme.
 3. Loading Sheets
 - a. Provide loading sheets for each DGP, including input and output boards for all field panels associated with the project.
 - b. OPS-PPSD will provide blank electronic sheets for contractor use.
 - c. Provide a spreadsheet for each DGP. Name the spreadsheet with the DGP number (e.g. "Site Name DGP-01.xls")
- D. Pre-Acceptance Testing Submittals
 1. OPS-PPSD will provide blank testing forms for contractor to reproduce and fill out during testing.
 2. Contractor Field Test
 - a. Contractor performs the Contractor Field Test (CFT) of all devices utilizing OPS provided forms and submits test results to OPS-PPSD.
 3. Performance Verification Test
 - a. Based on the OPS-PPSD approval of the Contractor's Field Test, the COTR will schedule the PVT with the Contractor and OPS-PPSD.
 - b. OPS-PPSD will witness the Contractor conduct the PVT of all devices utilizing the same form as for the CFT.

E. Closeout Submittals

1. Project Redlines
 - a. Neatly maintain an up-to-date set of construction redlines detailing current location and configuration of the project components.
 - b. Mark the redline documents with the words 'Master Redlines' on the cover sheet and be maintained by the Contractor in the project office.
 - c. Field drawings shall be used for data gathering & field changes. These changes shall be made to the master redline documents daily. Field drawings shall not be considered "master redlines".
 - d. Provide access to redline documents anytime during the project for review and inspection by the COTR or authorized OPS representative.
 - e. Any project component or assembly that is not installed in strict accordance with the drawings shall be so noted on the drawings.
 - f. Submit the Master Redline document to the COTR and PPSD Security Engineer for review and approval of all changes or modifications to the documents prior to producing Record Construction Documents. The COTR shall be given a minimum of a thirty (30) day review period to determine the adequacy of the Master Redlines. If the master redlines are found suitable by the COTR and the PPSD Security Engineer, the COTR will initial and date each sheet and turn the redlines over to the Contractor for Record As-Built development.
2. Record Construction Documents (Record As-Built)
 - a. The submitted as built documents shall be in editable electronic formats and the ownership of the drawings shall be fully relinquished to the owner.

1.8 PROJECT PROCESS DIAGRAM

- A. The ESS Project Process Diagram (below) is provided to identify key consecutive or concurrent tasks and milestones required to ensure the project is completed prior to owner occupancy. Substantial completion means all systems have been fully tested and accepted in writing by OPS. Minor or non-life safety related punch list items may continue through owner occupancy, but shall be resolved within two (2) weeks of official date of occupancy.
- B. The contractor is encouraged to utilize the diagram for the development of project schedules, and coordinating submissions.



1.9 COORDINATION

- A. Coordinate arrangement, mounting, and support of electronic security equipment:
- B. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- C. To provide for ease of disconnecting the equipment with minimum interference to other installations.
- D. To allow right of way for piping and conduit installed at required heights.
- E. Ensure raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- F. Coordinate the installation of required supporting discipline devices placement and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- G. Coordinate the locations of access panels and doors for electronic security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- H. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.10 QUALITY ASSURANCE

- A. Contractor Qualifications
 - 1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the electronic security systems included in the project scope.
 - 2. Provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project.
 - 3. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system.
 - 4. Provide copies of system manufacturer certification for all technicians. Only utilize factory-trained technicians to install, program, and service the electronic security systems. The Lead Technician shall have a minimum of five (5) continuous years of technical experience in electronic security systems.
 - 5. The Contractor shall have a local service facility located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The COTR and the PPSD Security Engineer reserves the option of visiting the company's facility to verify the service inventory and presence of a local service organization.

6. Lead network engineer onsite configuring the security data network equipment must have a minimum of a Cisco CCNP route/switch certification.
7. Refer to Division 27 Specifications for additional requirements for cabling.

B. Electrical Components, Devices, and Accessories

1. 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. Material & Workmanship

1. Unless otherwise specifically provided under this contract, all equipment, material and articles to be incorporated in the work shall be new and of the most suitable grade for the purposes intended.
2. References to any equipment, material, article or patented process, by trade name, make or catalog number shall be regarded as establishing a standard of performance and quality, and shall not be construed as limiting competition.
3. When so directed, the Contractor shall submit samples for approval at the Contractor's expense. Equipment, materials, and articles installed or used without the required approval shall be at the Contractor's risk of rejection.
4. Warranties of all work and installed products shall be according to the Contract General Provisions.

1.11 MAINTENANCE & SERVICE

A. General Requirements

1. Provide services required and equipment necessary to maintain the electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system.
2. Provide necessary material required for performing scheduled adjustments or other non-scheduled work. Minimize impacts on facility operations when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.

B. Description of Work

1. The adjustment and repair of the security system includes the following items computers equipment, communications transmission equipment and data transmission media (DTM), local processors, security system sensors, access control equipment, facility interface, signal transmission equipment, intercoms, and video equipment.

C. Personnel:

1. Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. Advise the COTR and the PPSD Security Engineer in writing of the name of the designated service representative, and of any change in personnel. Provide the COTR and the PPSD Security Engineer with copies of system manufacturer certification for the designated service representative.

D. Emergency Service

1. The owner shall initiate service calls whenever the system is not functioning properly. Provide the owner with an emergency service center telephone number. Staff the emergency service center 24 hours a day 365 days a year.
2. The Smithsonian Institution has sole authority for determining catastrophic and non-catastrophic system failures.
3. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk. For catastrophic system failures, provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from notification.
4. For non-catastrophic failures, provide eight (8) hour service response with a defect correction time not to exceed 24 hours from notification.

E. Work Request

1. Separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. Deliver a record of the work performed within five (5) working days after the work was completed.

F. System Modifications

1. Make any recommendations for system modification in writing to the COTR and the PPSD Security Engineer. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the COTR and the PPSD Security Engineer.

1.12 PROJECT ENVIRONMENTAL CONDITIONS

A. Control Station

1. Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, non-condensing.

B. Interior, Controlled Environment

1. System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 1 enclosure.

C. Interior, Uncontrolled Environment

1. System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (-18 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 4x enclosures.

D. Exterior Environment

1. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -30 to 122 deg F (-34 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 24 in (610 mm) thick. NEMA 250, Type 4X enclosures.

E. Hazardous Environment

1. System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

F. Corrosive Environment

1. For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

G. Security Environment

1. Use vandal resistant enclosures in high-risk areas where equipment may be subject to damage.

1.13 EQUIPMENT AND MATERIALS

A. General Equipment Requirements

1. Equipment and materials shall be standard, current products of the manufacturer, and be suitable for the systems being installed and the intent of the design.
2. Any material, device, or equipment damages including dents and marred finishes before or during installation and before acceptance of the completed system, shall be replaced unless repairs can be made that are acceptable to the COTR and the PPSD Security Engineer. Any such replacement or repairs, including repairs to the finish, shall be made at no cost to the Owner.
3. Parts of the project site are finished spaces, including paint, trim, wall covering, floor treatments, lighting, and building mechanical systems. Therefore, perform the work specified herein, such that, at the completion of his work, all finished space is restored to the original condition existing prior to the commencement of work. During the course of performing the work specified herein, if the Contractor encounters any damaged finish in any area where the Contractor's work is to be performed, notify the COTR in writing prior to performing work in that area. Proceed with the work in these areas only after receiving written confirmation that the existing conditions have been documented and authorization has been given to proceed.

B. Nameplates

1. Provide nameplates for all non-field devices accessed by - Smithsonian Institution Security Maintenance Personnel. This includes but is not limited to the following:
 - a. Data Gathering Panels
 - b. Security Enclosures

- c. Network Switches
 - d. Fiber Switches
 - e. Servers
 - f. Workstations
 - g. Power Supplies (including electrical circuit)
 - h. Electrical Circuits
2. The laminated plastic shall be 0.06 in (1.6 mm) thick, black with white lettering center core. Nameplates shall be a minimum of 0.75 in (19 mm) high, with a minimum of 0.13 in (3.3 mm) high-engraved block lettering. Attach nameplates with screws or located as required by security documentation plans and specifications. All console monitors shall be labeled with the monitor number and intended function.
 3. Submit planned naming conventions for approval.

1.14 COMPONENT ENCLOSURES

A. Tamper Provisions and Tamper Switches

1. Enclosures with terminal strips or circuit boards require tamper switches.
2. Arrange tamper switches to initiate an alarm signal that will report to the monitoring station when the door or cover is moved.
3. Tamper switches shall be inaccessible until the switch is activated. Be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating. Be spring-loaded and held in the closed position by the door or cover and be wired so they break the circuit when the door cover is disturbed. Tamper circuits shall be adjustable type screw sets and shall be adjusted by the contractor to eliminate nuisance alarms associated with incorrectly mounted tamper device shall annunciate prior to the enclosure door opening (within 1/4 " tolerance).
4. The single gang junction boxes for the portrait alarming and pull boxes with less than 102 square mm will not require tamper switches.
5. All enclosures over 12 sq in (305 sq mm) shall be hinged with an enclosure lock.
6. Control Enclosures: Maintenance/Safety switches on control enclosures, which must be opened to make routing maintenance adjustments to the system and to service the power supplies, shall be push/pull-set automatic reset type.
7. Provide one (1) enclosure tamper switch for each 24 in (609 mm) of enclosure lock side opening evenly spaced.
8. All security screws shall be Torx-Post Security Screws.

1.15 WARRANTY

- A. The Contractor shall, as a condition precedent to the final payment, execute a written guarantee (warranty) to the COTR certifying all contract requirements have been completed according to the final specifications. Contract drawings and the warranty of all materials and equipment furnished under this contract are to remain in satisfactory operating condition (ordinary wear and tear, abuse and causes beyond his control for this work accepted) for one (1) year from the date the Contractor received written notification of final acceptance from the COTR and the PPSD Security Engineer. Repair or replace all defects or damages due to faulty materials or workmanship without delay, to the COTR's satisfaction, and at the Contractor's expense.

When equipment and labor covered by the Contractor's warranty, or by a manufacturer's warranty, have been replaced or restored because of its failure during the warranty period, the warranty

period for the replaced or repaired equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

PART 2 - PRODUCTS

2.1 THERE ARE NO PRODUCTS IN THIS SPECIFICATION

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SECURITY INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 GENERAL

- A. Install all system components and appurtenances in accordance with the manufacturer's instructions, ANSI C2, and furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.
- B. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.
- C. Firmly attach equipment to walls and ceiling/floor assemblies (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

- D. Current Site Conditions: Visit the site and verify site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect performance of the system to the COTR as part of the Pre-Installation Submittal. Take no corrective action without written permission from the COTR.

3.3 SYSTEM PROGRAMMING

A. General

- 1. The following Loading Sheet submittals are required:
 - a. Shop Drawings – Pre-Installation Submittal
 - b. Final Construction Document Submittal – Closeout Submittal
- 2. Loading Sheets
 - a. See the attached loading sheets. Refer to Section 1 regarding loading sheet submissions.
 - b. System Configuration and Data Entry:
 - 1) The contractor is responsible for providing all system configuration and data entry for the SMS and subsystems (e.g., intercom, Inovonics wireless, digital video recorders, network video recorders). All data entry shall be performed to Smithsonian Institution’s standards & guidelines. The Contractor is responsible for participating in all meetings with the OPS and the client to compile the information needed for data entry. These meetings shall be established at the beginning of the project and incorporated in to the project schedule as a milestone task. The contractor shall be responsible for all data collection, data entry, and system configuration. The contractor shall collect, enter, & program and/or configure the following components:
 - a) Access control system components
 - b) All intrusion detection system components
 - c) Video surveillance, control and recording systems
 - d) Intercom systems components
 - e) All other security subsystems shown in the contract documents
- 3. Graphics
 - a. Based on as-built drawings developed for the construction project, create all map sets and system icons showing locations of all alarms and field devices.
 - b. Produce graphical maps of all alarm points installed under this contract including perimeter and exterior alarm points.
 - c. Create and install all graphics needed to make the system operational.
 - d. Utilize data from the contract documents, Contractor’s field surveys, and all other pertinent information in the Contractor’s possession to complete the graphics.
 - e. Identify and request from the COTR and the PPSD Security Engineer, any additional data needed to provide a complete graphics package.
 - f. Graphics shall have sufficient level of detail for the system operator to assess the alarm.
 - g. Supply hard copy, color examples at least 8 x 10 in (203.2 x 254 mm) of each type of graphic to be used for the completed Security system. Deliver the graphics examples to the COTR and the PPSD Security Engineer for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires them.

B. Alarm / Event Identification Format for Monitoring Station

- 1. Initial Descriptor

- a. The Initial Descriptor is a brief description of the event taking place and shall be no more than 50 characters in length. Contact OPS-PPSD for any Building ID, Area ID or Device / Condition Type not listed below.
- b. Building ID
 - 1) This is a two (2) or four (4) character identification of the building where the event is taking place. This shall follow the standard format as shown in the listing below. Confirm buildings and identifications with the owner.

Building	ID	Building	ID
African Art	AA	Hirshhorn	HH
Air and Space	AS	Horticulture Greenhouse	HG
American History	AH	Library (STRI)	LB
American Indian (NY)	IN	Maintenance Shop (STRI)	TP
American Indian Mall	IM	MSC (Suitland)	MS
Anacostia	AN	NAOS (STRI)	NAOS
Ancon (STRI)	AC	National Zoological Park	NZ
Apollo Drive	AD	Natural History	NH
Arts and Industries	AB	NMAAHC	AAHC
Barro Colorado (STRI)	BC	Patent Office Building	PB
Bocas del Toro (STRI)	BT	Pennsy Drive	SISC
Capital Gallery	CG	Postal Museum	PM
Columbia Warehouse	CW	Quad	SQ
Conference Center (STRI)	CC	Renwick	RW
Cooper Hewitt (NY)	CH	Research Branch (NY)	RB
CRC (Suitland)	CR	Sackler	SK
Culebra (STRI)	CU	SAO Arizona	AZ
Dulles	DL	SAO Hilo HI	HI
Engineering Building (STRI)	EB	SAO Mauna Kea HI	MK
Folk Life Festival	FF	SCBI Front Royal VA	FZ
Freer	FR	SERC	SR
Galeta (STRI)	GA	SI Castle	SB
Gamboa (STRI)	GM	Tivoli Facility (STRI)	TV
Garber (Suitland)	GB	Tupper Facility (STRI)	TP
Herndon	HN	Victor Building	VB

- c. Monitor Point Location
 - 1) This is the monitor point physical location. There is no separation between the Building ID and the Monitor Point Location.
 - 2) Description of iStar:
 - a) The Monitoring Point Location includes a two (2) character descriptor for the iStar Cluster, followed by a colon and then a two (2) character descriptor for the iStar panel followed by a colon then a one (1) character space.
 - b) Next is the one (1) character descriptor for ACM # (1 or 2) 'ACM:#' followed by a one (1) character space.

- c) Next is the device connection location for where the device terminates using 'I8' for an I-8 module, 'R8' for an R-8 module, 'RDR' for a reader module, followed by a colon. Then a one (1) character number representing which module it is (i.e. the fourth I-8 module), followed by a colon. Last is a one (1) character number representing the input number on the module; the inputs on the ACM board require a two (2) character number.
- 3) Example of iStar
 - a) xx01:01 ACM:1:i06 = iStar Cluster 01, iStar #01, ACM #1, main panel, sixth input
 - b) xx01:02 ACM:2 I8:3:i6 = iStar Cluster 01, iStar #02, ACM#2, I-8 module #3, sixth input
 - c) xx02:16 ACM:1 R8:2:o4 = iStar Cluster 02, iStar #16, ACM #1, R-8 module #2, fourth output
 - d) xx01:15 ACM:1 RDR:4:i2 = iStar Cluster 01, iStar #15, ACM#1, reader module #4, second input
- d. Area ID (Type)
 - 1) This is a brief description of the location of the alarm / event. There shall be a one (1) character space between the Monitor Point Location and the Area ID. At a minimum level of description, this shall follow the standard format as shown in the listing below. Confirm areas and identifications with the owner.

Description	Area ID
Vault	VAULT
Collection Storage	COLL STORAGE
Archive Areas	ARCHIVE
Collection Archive Areas	COLL ARCHIVE
Collection Processing / Preparation Areas	COLL PREP ROOM
Alcohol Storage Areas	ALCOHOL
Cold Collection Storage Areas	COLD STORAGE
Curatorial Areas	CURATORIAL
Exhibit Gallery (XX To be replaced with Gallery No.)	GALLERY XX
Exhibit Alarms Located in Lobbies or Reception Areas	LOBBY EXHIBIT
Exhibit or Artifact Alarms in "Other" Areas	MISC EXHIBIT
Registrar Areas	REGISTRAR
Perimeter Door, Glass Break, Motion	PERIMETER
Staff Cafeteria	STAFF CAFE
Public Access Cafeteria	PUBLIC CAFE
Public Staff Separation Door	STAFF DOOR
Museum Shop	MUSEUM SHOP
Museum Shop Storage Areas	MUSEUM SHOP ST
Cash Processing Areas	CASH ROOM
Automated Teller Machines	ATM
Executive Office Space	EXECUTIVE
Support Staff Office Space	STAFF OFFICE

Description	Area ID
Loading Dock Areas	LOADING DOCK
Security Unit Control Room	UNIT CONTROL
Security Wire Closet	WIRE CLOSET OPS-
Computer Center Rooms	COMPUTER ROOM
Mechanical Room	MECHANICAL
Electrical Room	ELECTRICAL
Communication Closet	COMM CLOSET
Fabrication Shop	FABRICATION
Support Staff Storage Area	STAFF STORAGE
Warehouse Storage Area	WAREHOUSE
Shipping and Receiving Area	SHIPPING
Security Officer Kiosks / Posts	SECURITY POST
Information Booths	INFO BOOTH
Locker Rooms	LOCKER ROOM
Laboratories	LABORATORIES
Libraries	LIBRARY
Liquor Storage Areas	LIQUOR STORAGE
Child Care Centers	CHILD CARE
Photo Processing Laboratories	PHOTO LAB
Animal Area for Public Viewing	ANIMAL EXHIBIT
Animal Area not for Public Viewing	ANIMAL OFF-
Outside Animal Area	ANIMAL YARD
Marine Animal Area	ANIMAL TANK
Animal/Keeper Area	KEEPER
Keeper (only) Area	KEEPER SPACE

e. Device / Condition Type

- 1) This is a two (2) digit descriptor for the type of device / condition that initiated the alarm / event. There is a one (1) character space between the Area ID and the Device / Condition Type. This follows the standard format as shown in the listing below. Confirm device / condition identifications with the owner.

Type of Device / Condition	ID
Door Contact	DC
Motion Detector	MD
Vibration Detector	VD
Glass Break Detector	GB
Hold Up / Duress Button	HU
Bill Trap (Last Bill Detector)	BT
Door Held Open	HO
Door Forced Open	FO
Power Failure	PF
Tamper Alarm	TP

Type of Device / Condition	ID
Window Contact	WC
Hazard Alarm	HZ
Case / Display Alarm	CA
Low / Missing Battery	LB
Communication Failure	CF
Security Fault	SF
UPS / Power Supply Trouble	PT
Restore / Reset	RS
Proximity Alarm	PA
Pressure Mat	PM

Type of Device / Condition	ID
Delayed Egress Pre Alarm	DE
Temperature Alarm	TA
Shock Sensor	SS
Photo Beam	PB
Request to Exit	REX
Seismic Alarm	SA
Video Loss	VL
Supervision Error	SE

Type of Device / Condition	ID
HVAC Duct Alarm	DA
Lock Secure	LS
Battery Fail	BF
Tamper Alarm	TP
Lock	LK
Door Status Monitor	DSM
Sounder	SD

- f. Examples for the Initial Descriptor:
 - 1) National Museum of Natural History monitor point location DGP chain 1 DGP number 2 first I-8 input 4, collection storage motion detector in alarm.
 - a) NH01:02 I8:1:i4 COLL STORAGE MD
 - 2) Arts and Industries Building monitor point location DGP chain 3 DGP number 4 main panel input 6, public staff separation door contact.
 - a) AB03:04 M:i6 STAFF DOOR DC
- 2. Secondary Descriptor
 - a. The Secondary Descriptor is 128 characters
 - b. This is an in-depth description for the location of the alarm / event taking place. If multiple devices are connected to the same monitor point the number of devices should be indicated.
 - c. Examples for the secondary descriptor
 - 1) National Museum of Natural History monitor point location DGP chain 1, DGP number 6, I32 board input 31, collection storage motion detector in alarm.
 - a) NH01:06 I32:i31 COLL STORAGE MD: NMNH 5th Fl East Wing Rm. 5210 Motion Detectors (3).
 - 2) Arts and Industries Building monitor point location DGP chain 1, DGP number 2 third I-8 board input 5, public staff separation door forced open.
 - a) AB01:02 I8:3:i5 STAFF DOOR FO: AIB 1st Fl East Hall Card Access Door Forced Open.
 - d. Linked Instruction Event
 - 1) This is a full instructional description for the processing of the alarm / event and follows the standard format of:
 - a) Repeat 50 character descriptor
 - b) In-depth description of location
 - c) Response instructions
 - d) Logging instructions
 - e) Reset instructions
 - f) Nearest camera location (If multiple views are available list all)
 - g) DGP input is connected to
 - e. Examples for the linked instructional event
 - 1) National Museum of Natural History monitor point location DGP chain 1 DGP number 3, I32 board input 31, collection storage motion detector in alarm.

Step	Display
1	NH01:03 I32:i31 COLL STORAGE MD

Step	Display
2	5th fl east wing Rm. 5210 motion detectors (3)
3	Dispatch officer to investigate and report findings
4	Log officer's name and actions into computer log
5	Device resets automatically when motion has stopped
6	Nearest camera is No. (camera Nos. provides other views)
7	Device connected to DGP

A. Alarm / Event Mapping Requirements

1. General
 - a. All maps associated with alarm / event call-ups shall be a black foreground on a white background.
2. Map Information Screen
 - a. The map information screen shall provide access to three different map levels for each event
 - b. Building Floor Map
 - 1) This map has the quadrant where the event is taking place line colored blue or the colored event icon in place. Identify this map with the building name and floor at the bottom of the map.
 - c. Quadrant Map
 - 1) This is the map called up by the system automatically upon event activation. Identify this map with the building name, floor number, and quadrant at the bottom of the map. This map has the icon representing the event shown upon call up. Clicking on the icon or a map "zoom in" icon at this map level calls up the Area map.
 - d. Area Map
 - 1) This map represents the local area of the building where the event is taking place. This map contains all icons associated with this area. These icons are "living", changing colors as the associated devices change state. Identify this map with the building name, floor number, quadrant, and area name at the bottom of the map.
3. Mapping icons
 - a. Mapping icons are "living" changing color as the associated devices change state.
 - 1) Red = alarm / activated state
 - 2) Green = secure / normal state
 - 3) Yellow = masked, shunted, accessed, etc. state
 - b. Group and position mapping icons represented on the Area map as follows:
 - 1) Motion detectors providing back up to perimeter door(s) / window(s).
 - a) Place a single icon in a close geographical position to the protected door(s) or window(s), to represent all devices in the zone or group
 - 2) Motion detectors providing back up to public staff separation doors and other internal doors.
 - a) Place a single icon in a close geographical position to the protected door.
 - 3) Motion detectors providing volumetric protection of a room.
 - a) Place a single icon in the center of the room, to represent all devices in the zone or group
 - 4) Glass break detectors protecting perimeter windows

- a) Place a single icon in a close geographical position to the center of the window or group of windows, to represent all devices in the zone or group
- 5) Door contacts protecting individual perimeter doors or logical groups of perimeter doors.
 - a) Place a single icon in a close geographical position to the center of the door or group of doors, to represent all devices in the zone or group
- 6) Delayed egress pre alarm contacts protecting individual doors or logical groups of doors.
 - a) Place a single icon in a close geographical position to the center of the door or group of doors, to represent all devices in the zone or group.
- 7) Window contacts protecting individual perimeter windows or logical groups of perimeter windows.
 - a) Place a single icon in a close geographical position to the center of the window or group of windows, to represent all devices in the zone or group.
- 8) Card reader events to include door forced open and door held open alarms.
 - a) A single icon shall be the same as the door contact protecting the door.
 - b) Icon descriptor shall identify the appropriate event taking place.
- 9) Tamper alarms protecting panels in security closets.
 - a) Place a single icon in the center of the room, to represent all devices in the zone or group.
- 10) Tamper alarms protecting individual devices or logical groups of devices.
 - a) Place a single icon in close geographical position to the device or group of devices, to represent all devices in the zone or group.
- 11) Exhibit level case/display alarms.
 - a) A single icon shall represent all devices protecting the case/display.
 - b) Place icon directly over the case/display so the case outline is still visible below (around) the icon
 - c) Icon descriptor shall identify the appropriate device in alarm.
- 12) Vibration detectors protecting any physical barrier or point of entry.
 - a) Place a single icon in close geographical position to the physical barrier / point of entry or group of devices, to represent all devices in the zone or group.

B. System Programming

1. General Programming Requirements
 - a. Use the following section to identify the anticipated level of effort (LoE) required setup, program, and configuring the ESS.
 - b. Provide all setup, configuration, and programming to include data entry for the SMS and subsystems (e.g., video system, intercoms, digital video recorders, intrusion devices, maps and icons, time synchronization, including integration of subsystems to the SMS.
2. Configuration Management of Servers
 - a. Provide SI-OPS the security system servers for baseline configuration 90 days before system programming begins.

- b. Once the security system server is baselined according to SI-OCIO requirements the server will be returned to the security contractor for system programming.
- c. There are other programming requirements the contractor needs assistance on as follows:
 - 1) OPS has to enter the Levels and Permissions of programming
 - 2) Synchronize system with C-Cure Central
 - 3) Employee card reader data will be automatically entered in the system server
 - 4) OPS will enter Card reader Clearances
- 3. Level of Effort for Programming
 - a. Perform and complete system programming (including all data entry) at an offsite location using the Contractor's own copy of the C*Cure 9000 software which must be the same version SI is using.
 - b. Deliver the completed forms (loading sheets) to the COTR and PPSD Security Engineer for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires it.
 - c. Once system programming has been completed, deliver the programming to the COTR and the PPSD Security engineer on data entry forms (loading sheets) and an approved electronic medium.
 - d. System programming may not be uploaded until the COTR and the PPSD security Engineer provide written approval.
 - e. The Contractor is responsible for backing up the system prior to uploading new programming data.
 - f. Additional programming requirements are provided as follows.
 - 1) Programming for New SMS Server
 - a) Provide all other system related programming.
 - b) Upload personnel information (e.g., ID Cards backgrounds, names, access privileges, personnel photos, access schedules, personnel groupings)
 - c) Coordinate with OPS for device configurations, standards, and groupings. SI shall provide database to support Contractor's data entry tasks.
 - d) Conduct a weekly coordination meeting and work alongside OPS to ensure data uploading is performed without incident of loss of function or data loss.
 - 2) Programming for Existing SMS Servers
 - a) Perform all related system programming except for personnel data as noted.
 - b) The contractor is not responsible for uploading personnel information (e.g., ID Cards backgrounds, names, access privileges, access schedules, personnel groupings).
 - c) Conduct a weekly coordination meeting and work alongside OPS to ensure data uploading is performed without incident of loss of function or data loss.
 - d) Perform system programming for SMS servers using the Contractor's own server and software. These servers shall not be connected to existing devices or systems at any time.
 - g. Identify any additional data needed to provide a complete and operational system as described in the contract documents and request the information from the COTR and the PPSD Security Engineer.
 - h. Programming effort requires a high level of coordination between Contractor and OPS to ensure programming is performed in accordance with SI requirements and programming uploads do not disrupt existing systems functionality.

- 1) Conduct a weekly coordination meeting and work alongside OPS to ensure data uploading is performed without incident of loss of function or data loss.
 - i. Ensure data uploading is performed without incident or loss of function or data loss.
 - j. The following Level of Effort Chart is provided to communicate the expected level of effort required by contractors on SI ESS projects. Determine actual levels of effort prior to bidding on the project.

SMS Setup & Configuration

Description of Tasks	Develop System Loading Sheets	e.g., program monitoring stations, programming networks, interconnections between CCTV, intercoms, time synchronization
	Coordination	e.g., retrieve IP addresses, naming conventions, standard event descriptions, programming templates, coordinate special system needs
	Initial Set-up Configuration	e.g., Load system Operating System and Application software, general system configurations
	Graphic Maps	e.g., develop naming conventions, develop file folders, confirming accuracy of AutoCAD Floor Plans, convert file into jpeg file then to bitmap.bmp file
	System Programming	e.g., program monitoring stations, programming networks, interconnections between CCTV, intercoms, time synchronization
	Final Checks	e.g., check all system diagnostics (e.g., clients, panels)
	Level of Effort (Typical Tasks)	Load and set-up 4-6 CDs and configure servers (to configure Loading and Configuring software Administrative account, audit log Keystrokes, mouse clicks, multi-screen configuration

Electronic Entry Control Systems

Description of Tasks	Develop System Loading Sheets	e.g., setup of device, door groups & schedules, REX, Locks, link graphics
	Coordination	e.g., confirming device configurations, naming conventions, event description and narratives
	Initial Set-up Configuration	e.g., enter data from loading sheets; configure components, link events, cameras, and graphics
	Graphic Maps	e.g., develop naming conventions, develop file folders, confirming accuracy of AutoCAD Floor Plans, convert file into jpeg file then to bitmap.bmp file
	System Programming	e.g., setup of device, door groups & schedules, REX, Locks, link graphics
	Final Checks	e.g., performing entry testing to confirm correct set-up and configuration
	Level of Effort (Typical Tasks)	e.g., creating a door, door configuration, adding request to exit, door monitors and relays, door timers, door related events (e.g., access, access denied, forced open, held open), linkages, controlled areas, advanced door monitoring, time zones, sequence of operations

Intrusion Detection Systems

Description of Tasks	Develop System Loading Sheets	e.g., enter door groups & schedules, link devices - REX, lock, & graphics
	Coordination	e.g., confirming device configurations, naming conventions, event description and narratives
	Initial Set-up Configuration	e.g., enter data from loading sheets; configure components, link events, cameras, and graphics
	Graphic Maps	e.g., develop naming conventions, develop file folders, confirming accuracy of AutoCAD Floor Plans, convert file into jpeg file then to bitmap.bmp file
	System Programming	e.g., enter door groups & schedules, link devices - REX, lock, & graphics
	Final Checks	e.g., walk test, device position, and masking
	Level of Effort (Typical Tasks)	e.g., setting up monitoring and control points (e.g., motion sensors, glass breaks, vibration sensor, strobes, sounders) creating intrusion zones, creating arm/disarm panel, timed sequences, time zones, icon placements on graphic maps, clearance levels, events (e.g., armed, disarmed, zone violation, device alarm activations), LCD reader messages,

CCTV Systems

Description of Tasks	Develop System Loading Sheets	e.g., programming call-ups recording
	Coordination	e.g., confirming device configurations, naming conventions
	Initial Set-up Configuration	e.g., enter data from loading sheets; camera naming convention, sequences, configure components)
	Graphic Maps	e.g., develop naming conventions, develop file folders, confirming accuracy of AutoCAD Floor Plans, convert file into jpeg file then to bitmap.bmp file
	System Programming	e.g., programming call-ups recording
	Final Checks	e.g., confirm area of coverage, call-up per event generated and recording rates
	Level of Effort (Typical Tasks)	e.g., setting up cameras points, recording ratios (e.g., normal, alarm event) timed recording, linkages, maps placements, call-ups

Intercoms Systems

Description of Tasks	Develop System Loading Sheets	e.g., programming events & call-ups
	Coordination	e.g., confirming device configurations, naming conventions, event description and narratives
	Initial Set-up Configuration	e.g., enter data from loading sheets; configure components, link events, cameras, and graphics
	Graphic Maps	e.g., develop naming conventions, develop file folders, confirming accuracy of AutoCAD Floor Plans, convert file into jpeg file then to bitmap.bmp file
	System Programming	e.g., programming events & call-ups
	Final Checks	e.g., confirm operation, SMS event generation and camera call-up
	Level of Effort (Typical Tasks)	e.g., setup linkages, events for activations, device troubles, land devices on graphic maps

Console Monitoring Components

Description of Tasks	Develop System Loading Sheets	N/A
	Coordination	per monitor
	Initial Set-up Configuration	per monitor
	Graphic Maps	e.g., develop naming conventions, develop file folders, confirming accuracy of AutoCAD Floor Plans, convert file into jpeg file then to bitmap.bmp file
	System Programming	N/A
	Final Checks	per monitor
	Level of Effort (Typical Tasks)	N/A

Note: Programming tasks are supported through the contractor's development of the Submittals.

END OF SECTION 280500.10

SECTION 280509.10 – SURGE PROTECTION FOR ELECTRONIC SECURITY

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. Section 280500.10 Common Work Results for Electronic Security.

1.2 SYSTEM DESCRIPTION

- A. This specification is for surge protection for electronic security systems (ESS).
- B. Transient Voltage Surge Suppression:
 - 1. Protect cables and conductors extending beyond building façade, except fiber optic cables, which serve as communication, control, or signal lines against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection.
 - 2. The TVSS device shall be UL listed in accordance with Standard TIA 497B.
 - 3. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator.
 - 4. Provide protection at the field device and on each wire line circuit at the first accessible location within the building but not more than 50 ft (15 m) of the building cable entrance.
 - 5. Fuses shall not be used for surge protection.
 - 6. Test the inputs and outputs in both normal mode and common mode to verify there is no interference.
 - 7. General Performance Requirements
 - a. A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
 - b. An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. TVSS

1.4 REFER TO 280500.10 FOR ALL OTHER PART I REQUIREMENTS

PART 2 - PRODUCTS

2.1 TVSS, ETHERNET POE

- A. Ditek DTK-MRJPOES or approved equivalent
- B. Minimum Required Features and Specifications
 - 1. Suitable for surface mounting or DIN rail (DTK_DRK required) within the enclosure/rack.
 - 2. Protects power, video and data PoE circuits
 - 3. RJ45 connection with external grounding screw
 - 4. Operating Temperature: -40 to 158 deg F (-40 to 70 deg C)

2.2 TVSS DTK-MRJPOEX, OUTDOOR RATED

- A. Acceptable Manufacturers
 - 1. Ditek
 - 2. Approved Equivalent
- B. Ditek DTK-MRJPOEX or approved equivalent
- C. Minimum Required Features and Specifications
 - 1. Housing – Polycarbonate, NEMA 4X
 - 2. Shielded RJ45 connections
 - 3. Operating Temperature: -40 to 158 deg F (-40 to 70 deg C)
 - 4. PoE Plus, HiPoE for high-wattage applications
 - 5. Compatible with CAT5e, CAT6 and CAT6A cabling

2.3 TVSS, 120V

- A. Acceptable Manufacturers
 - 1. Ditek
 - 2. Approved Equivalent
- B. Ditek DTK-120HW approved equivalent
- C. Minimum Required Features and Specifications
 - 1. Suitable for surface mounting or DIN rail (DTK_DRK required) within the enclosure/rack.
 - 2. Protects power (120V)
 - 3. Approved for 20A Circuit Breakers
 - 4. Operating Temperature: -31 to 176 deg F (-35 to 80 deg C)

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 270526.10 "Grounding and Bonding for Security Systems" for grounding conductors and connectors.

3.2 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

3.3 REFER TO 280500.10 FOR ALL OTHER PART III REQUIREMENTS

END OF SECTION 280509.10

SECTION 280513.10 – SERVERS, WORKSTATIONS, AND STORAGE FOR ELECTRONIC SECURITY

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. Section 280500.10 Common Work Results for Electronic Security.

1.2 SYSTEM DESCRIPTION

- A. This specification is for the storage directly supporting the electronic security systems (ESS) including all software licenses.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. NVR's

1.4 REFER TO 280500.10 FOR ALL OTHER PART I REQUIREMENTS

PART 2 - PRODUCTS

2.1 NETWORK VIDEO RECORDER

- A. Provided by the Owner.
- B. Contractor shall provide programming as needed to connect all cameras in the system.
- C. Acceptable Manufacturers
 - 1. American Dynamics
- D. American Dynamics [ADVER168R5DJ] or approved equivalent
- E. Minimum Required Features and Specifications
 - 1. OS Drive: Redundant 480GB SSD SATA (RAID 1)
 - 2. Network Interface: 2 x 10 Gigabit Ethernet NICs; 2 x 1 Gigabit Ethernet NICs
 - 3. 168 TB RAID 5 Video Storage

4. iSCSI External Storage
5. Redundant 750 W Power Supply
6. 1000 Mbps Video Recording Throughput

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 270526.10 "Grounding and Bonding for Security Systems" for grounding conductors and connectors.

3.2 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

3.3 REFER TO 280500.10 FOR ALL OTHER PART III REQUIREMENTS

END OF SECTION 280513.10

SECTION 280531.10 – COMMUNICATIONS EQUIPMENT FOR ELECTRONIC SECURITY

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. Section 280500.10 Common Work Results for Electronic Security.

1.2 SYSTEM DESCRIPTION

- A. This specification is for the communications equipment directly supporting the electronic security systems (ESS).

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Environmentally Hardened Network Switches

1.4 REFER TO 280500.10 FOR ALL OTHER PART I REQUIREMENTS

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY HARDENED 8-PORT NETWORK SWITCH

- A. Acceptable Manufacturers
 - 1. Comnet
 - 2. Blackbox
- B. Comnet CNGE2FE8MSPOE+ or approved equivalent
- C. Minimum Features and Specifications
 - 1. Environmentally hardened
 - 2. Eight (8) 10/100 BASE-TX ports
 - 3. Two (2) 10/100/1000TX or 100/1000FX combo ports
 - 4. The eight (8) electrical ports support the 10/100 Mbps IEEE 802.3at PoE+
 - 5. Cooling: Natural convection
 - 6. Operating Temperature: -40 to 167 deg F (-40 to 75 deg C)
 - 7. MTBF: 100,000 hours
 - 8. Lifetime warranty

D. Additional Required Options / Parts

1. Comnet PS-DRA240-48A or approved equivalent
 - a. Universal AC input: 90 to 264 VAC, 47-63Hz
 - b. Mounts on standard 0.3 in (7.5 mm) or 0.6 in (15 mm) DIN-rail
 - c. Adjustable output voltage range support
 - d. High operating efficiency; up to 87%

2.2 ENVIRONMENTALLY HARDENED 4-PORT NETWORK SWITCH

A. Acceptable Manufacturers

1. Comnet
2. Blackbox

B. Comnet CNGE2FE4SMSPOEHO or approved equivalent

C. Minimum Features and Specifications

1. Environmentally hardened
2. Two (2) 802.3at PoE+ (30W) copper ports operating at 10/100MBPS
3. Two (2) PoE++ (60W) copper ports operating at 10/100MBPS
4. Two (2) Gbps optical SFP ports
5. Current draw: 5A max, with PoE, 1A without PoE
6. Cooling: Natural convection
7. Operating Temperature: -40 to 167 deg F (-40 to 75 deg C)
8. MTBF: 100,000 hours
9. Lifetime warranty

D. Additional Required Options / Parts

1. Comnet PS-DRA240-48A or approved equivalent
 - a. Universal AC input: 90 to 264 VAC, 47-63Hz
 - b. Mounts on standard 0.3 in (7.5 mm) or 0.6 in (15 mm) DIN-rail
 - c. Adjustable output voltage range support
 - d. High operating efficiency; up to 87%

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 270526.10 "Grounding and Bonding for Security Systems" for grounding conductors and connectors.

3.2 IP ADDRESSING

- A. Refer to 280500.10 Submittals for requirements.

3.3 WARRANTY

- A. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover.

3.4 REFER TO 280500.10 FOR ALL OTHER PART III REQUIREMENTS

END OF SECTION 280531.10

SECTION 280800.10 – COMMISSIONING OF ELECTRONIC SECURITY

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. Section 280500.10 Common Work Results for Electronic Security.

1.2 SYSTEM DESCRIPTION

- A. This specification is for the commissioning of electronic security systems (ESS).

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Commissioning of the Electronic Security Systems

1.4 REFER TO 280500.10 FOR ALL OTHER PART I REQUIREMENTS

PART 2 - PRODUCTS

2.1 THERE ARE NO PRODUCTS IN THIS SPECIFICATION

PART 3 - EXECUTION

3.1 PERFORMANCE REQUIREMENTS

- A. General
 - 1. Refer to Project Process Diagram (PPD) in 280500.10. Utilize the PPD to develop effective and timely project schedules and submissions to ensure project is substantially complete prior to occupancy.

3.2 CONTRACTOR'S FIELD TESTING

- A. Perform the Contractor Field Test (CFT) of all devices utilizing OPS provided forms.
- B. Submit test results, including journal logs from CCURE, to COTR and OPS-PPSD.

3.3 PERFORMANCE VERIFICATION TEST (PVT)

- A. Based on the OPS-PPSD approval of the Contractor's Field Test, the COTR will schedule the PVT with the Contractor and OPS-PPSD.
- B. OPS-PPSD will witness the Contractor conduct the PVT of all devices utilizing the same form as for the CFT.
- C. OPS-PPSD reserves the right to stop and abort testing as soon as 10 technical deficiencies are found requiring correction.
 - 1. If the acceptance test is aborted, the re-test will commence from the beginning with a retest of components previously tested and accepted.
 - 2. The Contractor is responsible for all time, travel, and lodging expenses incurred for personnel required to be present for resumption of the PVT.
- D. The PVT also includes a physical inspection of the installation quality and workmanship.
- E. Submit test results, including journal logs from CCURE, to COTR and OPS-PPSD.

3.4 REFER TO 280500.10 FOR ALL OTHER PART III REQUIREMENTS

END OF SECTION 280800.10

SECTION 282000 – VIDEO

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. Section 280500.10 Common Work Results for Electronic Security.

1.2 SYSTEM DESCRIPTION

- A. The Video Assessment and Surveillance System (VASS) is an enterprise class system. Integrate with the PACS so the PACS provides a single unified control and management platform. Link video to events and alarms on all other systems (intrusion detection, intercommunications, and PACS) with the PACS.
- B. This is an extension of the Owner's existing American Dynamics Victor system.
- C. The existing system head-end in Castle building has expansion capacity to accommodate the new cameras. The Contractor is responsible for licenses.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Cameras
 - 2. Ethernet Over Coax Converter
 - 3. Video Desktop Controller
 - 4. Network Video Encoder
 - 5. Transcoder

1.4 REFER TO 280500.10 FOR ALL OTHER PART I REQUIREMENT

PART 2 - PRODUCTS

2.1 MULTI-LENS DOME CAMERA, 32MP

- A. Acceptable Manufacturers
 - 1. Hanwha Vision
 - 2. Approved Equivalent

B. Hanwha Vision PNM-C32083RVQ or approved equivalent

C. Minimum Required Features and Specifications

1. Outdoor vandal-rated network Multi-Sensor Multi-Directional dome camera
2. Image Sensor: 4 x 8MP
3. Resolution
 - a. Total: 15360 H x 8640 V
 - b. Per Sensor: 3840 H x 2160 V
4. Wide Dynamic Range: 120dB
5. Frame Rates:
 - a. 20fps
6. 3.54-6.69mm motorized varifocal lens
7. PoE+
8. Outdoor rated IP66, NEMA4X, and IK-10 Impact-Resistant Housing
9. Object detection, IVA, Appear/Disappear Video Analytics
10. Operating Temperature: -40 to 131 deg F (-40 to 55 deg C)

2.2 FIXED DUAL-LENS DOME CAMERA, 12MP

A. Acceptable Manufacturers

1. Hanwha Vision
2. Approved Equivalent

B. Hanwha Vision PNM-12082RVD or approved equivalent

C. Minimum Required Features and Specifications

1. Dual-head camera housing
2. Image Sensor: 2 x 6MP
3. Effective Pixels: 3328 H x 1872 V
4. Wide Dynamic Range: extremeWDR (120dB)
5. Frame Rates:
 - a. H.265/H.264: Max. 15fps
6. 3.54-6.69mm motorized varifocal lens
7. Remote Focus
8. Day & Night Auto (ICR)
9. Max 21W, typical 16.5W (PoE)
10. Outdoor rated IP66, NEMA4X, and IK-10 Impact-Resistant Housing
11. Defocus detection, Motion Detection, Tampering, Virtual area (Appear/Disappear), Virtual area (Loitering/Intrusion/Enter/Exit)
12. H.265/H.264: Main/Baseline/High, MJPEG
13. Minimum Illumination:
 - a. Color: 0.16 Lux
 - b. B/W (Night Mode): 0.016 Lux
14. Operating Temperature: -40 to 131 deg F (-40 to 55 deg C)
15. Humidity: Less than 95% RH (non-condensing)
16. Total dimensions: 8.46" (W) x 5.31" (D) x 3.67" (H) (215 x 135 x 93.2 mm)

2.3 FIXED DOME CAMERA, 2MP

- A. Acceptable Manufacturers
 - 1. Illustra
 - 2. Approved Equivalent
- B. Illustra cameras IPS02-D12-OI04 or approved equivalent
- C. Minimum Required Features and specifications
 - 1. Remote setup
 - 2. Image Sensor: 2 MP
 - 3. Resolution: 1920 H x 1080 V
 - 4. Minimum Illumination:
 - a. Color (Day Mode): 0.01 Lux
 - b. B/W (Night Mode): 0.0001 Lux
 - c. B/W (Night Mode): 0.0 Lux, IR sensitive
 - 5. Motorized Varifocal and Focus, P-Iris
 - 6. Power: Power over Ethernet (PoE) IEEE 802.3af/802.3at Type 1 Class 3
 - 7. Max Draw: 12.95W (PoE)
 - 8. Allows 90 degree image rotation for better coverage in hallways and corridors
 - 9. True day/night CF removal
 - 10. Max Frame Rate: 60fps
 - 11. Micro SDXC Card Slot up to 1TB
 - 12. Outdoor rated IP66/IP67 and IK-10 Impact-Resistant Housing
 - 13. Operating Temperature: -58 to 149 deg F (-50 to 65 deg C)
 - 14. Total dimensions: 5.4 x 5.3 in (138 x 135 mm)

2.4 FIXED DOME CAMERA, 5MP

- A. Acceptable Manufacturers
 - 1. Hanwha Vision
 - 2. Approved Equivalent
- B. Hanwha Vision XNV-8080R or approved equivalent
- C. Minimum Required Features and specifications
 - 1. Image Sensor: 5MP
 - 2. Effective Pixels: 2560 H x 1920 V
 - 3. Wide Dynamic Range: 120dB
 - 4. Frame Rates:
 - a. H.265/H.264: Original view - Max. 30fps
 - 5. 3.9-9.4mm (2.4x) motorized varifocal lens
 - 6. Day & Night Auto (ICR)
 - 7. Max 12.95W
 - 8. Outdoor rated IP66, NEMA 4X, and IK-10 Impact-Resistant Housing

9. Defocus detection, Directional detection, Fog detection, Motion detection, Appear/Disappear, Enter/Exit, Loitering, Tampering, Virtual line, Audio detection, Face detection, Digital auto tracking, Sound Classification
10. H.265, H.264, MJPEG Codec Supported
11. Minimum Illumination:
 - a. Color: 0.7 Lux
 - b. B/W (Night Mode): 0 Lux
12. Operating Temperature: -40 to 131 deg F (-40 to 55 deg C)
13. Humidity: Less than 90% RH
14. Total dimensions: 6.3 x 4.67" (160 x 118.5 mm)

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 270526.10 "Grounding and Bonding for Security Systems" for grounding conductors and connectors.

3.2 GENERAL

- A. Install all system components and appurtenances in accordance with the manufacturer's instructions, ANSI C2, and furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.
- B. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.
- C. Attach equipment to walls and ceiling/floor assemblies and be held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
- D. Current Site Conditions: Visit the site and verify site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect performance of the system to the Owner. Do not take any corrective action without written permission from the Owner.
- E. Warranty: During the warranty period, the GC shall report all parts replaced/repaired; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover
- F. Cameras
 1. Install cameras with the proper focal length lens as indicated for each zone
 2. Set cameras with fixed iris lenses to the proper f-stop to give full video level

3. Aim camera to give field of view as needed to cover the alarm zone / intended field of view
 4. Aim fixed mount cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun
 5. Focus the lens to give a sharp picture over the entire field of view.
 6. Use a fine focus target for final focus adjustments.
- G. Camera Pole and Mounts: The Contractor shall install the camera mount as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing with maximum wind and ice loading encountered at the site; provide a foundation for each camera pole as specified and shown; provide a ground rod for each camera pole of correct length as dictated by soil conductivity and connect the camera pole to the ground rod; provide electrical and signal transmission cabling to the mount location; connect signal lines and AC power to mount interfaces; connect pole wiring harness to camera.

3.3 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

3.4 REFER TO 280500.10 FOR ALL OTHER PART III REQUIREMENTS

END OF SECTION 282000

SECTION 283100 – INTRUSION DETECTION

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. Section 280500.10 Common Work Results for Electronic Security.

1.2 SYSTEM DESCRIPTION

- A. The Intrusion Detection System is an inherent part of the PACS system. Link alarms to video system for event driven camera call-up and recording.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Motion sensors
 - 2. Door position switches
 - 3. Duress buttons

1.4 REFER TO 280500.10 FOR ALL OTHER PART I REQUIREMENTS

PART 2 - PRODUCTS

2.1 360 DEGREE DUAL-TECH MOTION SENSOR

- A. Acceptable Manufacturers
 - 1. Bosch
 - 2. Approved Equivalent
- B. Bosch DS9370 and DS9371 or approved equivalent.
- C. Minimum Features and Specifications
 - 1. Up to 25 ft (7.6 m) mounting height
 - 2. 360 degrees x 70 ft (20 m) diameter pattern
 - 3. Fully-adjustable optical arrays for coverage customization
 - 4. Rated for use in difficult environment to reduce false alarms from background disturbances such as air movement and hanging signs.

5. Combination of passive infrared (PIR) detection, microwave detection, and advanced signal processing technology.
6. Built-in tamper switch
7. Operating Temperature: -40 to 120 deg F (-40 to 49 deg C)
8. Dimensions: 3.5 x 7 in (8.9 x 17.8 cm)
9. Voltage: 9 to 15 VDC
10. UL Listed

2.2 DOOR POSITION SWITCH; RECESSED

A. Acceptable Manufacturers

1. Magnasphere
2. Approved Equivalent

B. Magnasphere MSS-19 Series, MSS-25 Series or approved equivalent

C. Minimum Features and Specifications

1. UL 634 Listed
2. Recessed
3. Magnetic tamper
4. 0.75 in (19 mm) or 1 in (25.4 mm) diameter
5. Capable of operating with a 0.5 in (13 mm) gap
6. Screw Terminals or 12 in (305 mm) wire leads, #22 AWG, solid

2.3 DOOR POSITION SWITCH; SURFACE

A. Acceptable Manufacturers

1. Magnasphere
2. Approved Equivalent

B. Magnasphere MSS-3X0S Series or approved equivalent

C. Minimum Features and Specifications

1. UL 634 Listed
2. Surface mounted
3. Closed Loop
4. Magnetic tamper
5. Size: 2 x 0.5 x 1 in (51 x 12.7 x 25.4 mm).
6. Capable of operating with a 0.3 in (7.6 mm) gap
7. Armored cable lead 24 in (61 mm)
8. Only for use on hatches where a standard recessed contact cannot be used

2.4 DURESS ALARM

A. Acceptable Manufacturers

1. Amseco
 2. Approved Equivalent
- B. Amseco HUSK-20 or approved equivalent.
- C. Minimum Features and Specifications
1. Form C contact
 2. Switch shall lock in activated position until reset with a key.
 3. Push Button: Finger activated.
 4. Latching with key reset
 5. Status window indicator
 6. Switch rating: 5A @ 30VDC max
 7. Operating Temperature: -4 to 176 deg F (-20 to 80 deg C)
 8. UL 636 listed

PART 3 - EXECUTION

3.1 GROUNDING

- A. Comply with requirements in Section 270526.10 "Grounding and Bonding for Security Systems" for grounding conductors and connectors.

3.2 SYSTEM INTEGRATION

- A. Integrate intrusion detection system with the following systems and equipment:
1. Electronic door hardware – locking/unlocking, request-to-exit
 2. Elevators – none
 3. Network lighting controls – none
 4. Intercommunications and program systems – none
 5. Public address and mass notification systems – none
 6. Access control – door contacts and IDS zones
 7. Fire-alarm system – none
 8. Perimeter security system – none
 9. Video surveillance – video call-up of appropriate camera(s) for each alarm activation

3.3 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.

3.4 GENERAL

- A. Supervision

1. Configure system components to continuously monitor for normal, alarm, line supervision, tamper, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
2. Trouble Condition Signal: Indicates the system is not fully functional (e.g. sensor battery failure, open or shorted/grounded transmission line conductors, or device cover removed).

B. Warranty

1. During the warranty period, the GC shall report all parts replaced/repared; labor hours spent for actual work, and reason for repair/replacement. The GC shall provide documentation of maintenance and repairs to the CM prior to asset turnover

3.5 REFER TO 280500.10 FOR ALL OTHER PART III REQUIREMENTS

END OF SECTION 283100

SECTION 311000 – SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Protecting existing vegetation to remain.
- B. Removing existing vegetation.
- C. Clearing and grubbing obstructions, trees, shrubs, and other vegetation, including grinding stumps and removing roots and debris.
 - 1. Chipping removed tree branches and disposing off-site.
- D. Stripping and stockpiling topsoil and disposing of surplus topsoil.
- E. Stripping and stockpiling rock and disposing of surplus rock.
- F. Removing existing above- and below-grade site improvements.
- G. Disconnecting, capping or sealing, and removing or abandoning site utilities.
- H. Providing temporary erosion- and sedimentation-control measures.

1.2 REFERENCES

- A. DOEE – Department of Energy and Environment.

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.

1.6 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 alternative 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 sediment control measures are in place.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to the Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. 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 the erosion and sediment control plans, and in accordance with the Department of Energy & Environment (DOEE) Standards and Specifications for Soil Erosion and Sediment Control.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during construction.

3.3 UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.

- C. 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 Owner no less than three days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions and grass to permit installation of new construction.
 - 1. Cut minor roots and branches of trees not indicated to be removed in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 2. Remove roots and debris extending to a depth of 18 inches below exposed subgrade.
 - 3. Chip removed tree branches and stockpile in areas approved by Owner until the items can be properly disposed of off-site.
- 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.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Limit height of stockpiles to 72 inches.
 - 2. Dispose of excess topsoil as specified for waste material disposal.
 - 3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 SITE IMPROVEMENTS

- A. Remove existing above and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove paving, gravel, 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.

3.7 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.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 31 1000

SECTION 31 2000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for walks, pavements, turf and grasses.
2. Subbase course for concrete pavements.
3. Subbase course for asphalt paving.
4. Excavating and backfilling trenches for utilities.

B. References:

1. All material and installation shall comply with applicable District and National codes including the following:
 - a. Smithsonian Facilities Design Standards Latest Edition.
 - b. District of Columbia Department of Transportation (DDOT) Standards and Specifications for Highways and Structures 2013 or Latest Edition.
2. In the case where two codes differ on the same topic, the more stringent requirements shall be followed subject to approval by the Smithsonian Institute.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength 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. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Contractor. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10-ft in width and more than 30-ft in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Contractor. Unauthorized excavation, as well as remedial work directed by the Contractor, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

- G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1.00-yd³ for bulk excavation or 0.80-yd³ 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 45-inch wide, maximum, short-tip-radius rock bucket; rated at no less than 138-hp flywheel power with bucket-curling force of no less than 28,000 lbf and stick-crowd force of no less than 18650 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 48,500 lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- H. Structures: Buildings, footings, foundations, walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Course placed between the subgrade and base course or course placed between the subgrade and a cement concrete pavement or a cement concrete walk.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of plastic warning tape.
 - 2. Geotextile.
 - 3. Vapor barrier.
 - 4. Drainage material.
 - 5. Waterproofing.
 - 6. Controlled low-strength material, including design mixture.
- 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 D2487 of each on-site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D698 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.

1.4 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing, as documented according to ASTM D3740 and ASTM E548.

- B. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section QUALITY REQUIREMENTS. Review the earthwork procedures and responsibilities including testing and inspection procedures and requirements.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by the Owner and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Contractor no less than two days 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.
- 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.
- C. If available, refer to the Geotechnical Engineering Report prepared and associated boring and test data for information pertaining to the general subsurface conditions within the project site.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Structural Fill Soils: ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SM, SC or a combination of these groups; free of rock or gravel larger than 3-inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Non-Structural Soils: Soil Classification Groups CL or ML according to ASTM D2487 or a combination of these groups.
- D. Unsatisfactory Soils: Soil Classification Groups OL, CH, MH, OH, and PT according to ASTM D2487 or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction per ASTM D698.
- E. Subbase Material: Naturally or artificially well-graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2 inch sieve and no more than 15 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially well-graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2 inch sieve and no more than 15 percent passing a No. 200 sieve.

- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 1-inch sieve and no more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; 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. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

- A. Controlled Low-Strength Material: Low-density, self-compacting, flowable concrete material as follows:
 - 1. Portland Cement: ASTM C150, Type I or II.
 - 2. Fly Ash: ASTM C618, Class C or F.
 - 3. Normal-Weight Aggregate: ASTM C33, 0.4-inch nominal maximum aggregate size.
 - 4. Foaming Agent: ASTM C869.
 - 5. Water: ASTM C94.
 - 6. Air-Entraining Admixture: ASTM C260.
- B. Produce low-density, controlled low-strength material with the following physical properties:
 - 1. As-Cast Unit Weight: 30 to 36 lb/ft³ at point of placement, when tested according to ASTM C138.
 - 2. Compressive Strength: 80 psi, when tested according to ASTM C495.
- C. Produce conventional-weight, controlled low-strength material with 80 psi compressive strength when tested according to ASTM C495.

2.4 ACCESSORIES

- A. 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; colored 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.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored 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 4 - EXECUTION

4.1 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. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, deleterious materials, and all overburden material in structurally-supported areas to native residual soil or rock as specified in Division 31 Section SITE CLEARING.
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section SITE CLEARING, during earthwork operations.
- D. Stockpile on-site materials anticipated for re-use after screening. Care shall be taken to avoid blending with the deleterious materials.

4.2 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.
- C. 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.

4.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

4.4 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. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24-inches outside of concrete forms other than at footings.
 - b. 12-inches outside of concrete forms at footings.
 - c. 6-inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6-inches beneath bottom of concrete, mat foundations, footings, and slabs on grade unless otherwise required by design for settlement considerations.
 - f. 12-inches beneath pipe in trenches, and the greater of 24-inches wider than pipe or 43-inches wide.

4.5 EXCAVATION FOR STRUCTURES

- A. Excavate to 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. Excavation for Underground Tanks, Basins, and Mechanical or 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.

4.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

4.7 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: 12-inches each side of pipe or conduit.

4.8 SUBGRADE INSPECTION

- A. Notify Contractor when excavations have reached required subgrade.
- B. If Contractor or Geotechnical Testing Agency determine that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

- C. Compact and proof-roll soil foundation subgrades using hand-operated compaction equipment to the satisfaction of the Geotechnical Testing Agency.
- D. Proof-roll soil subgrade below the building slabs, pavements, footings and slabs-on-grade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction then repeat proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing no less than 15.5 tons. Alternate equipment must be approved by the Contractor.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Contractor and Geotechnical Testing Agency and replace with compacted backfill or fill as directed.
- E. Rock subgrades should be scaled of loose material and leveled. Compressed air should be used to clean all rock surfaces prior to placement of mud mat and reinforcing steel or concrete. Geotechnical Testing Agency shall confirm quality of rock meets design requirements prior to installation of steel or concrete.
- F. Subgrades beneath structural slab areas shall be sufficient strength to support construction activities and machinery without excessive damage.
- G. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- H. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Contractor, without additional compensation.

4.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 1450 psi, may be used when approved by the Contractor.
 - 1. Fill unauthorized excavations under other construction or utility pipe as directed by the Contractor.

4.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing at locations acceptable to Owner. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
- B. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- C. Contractor shall be solely responsible for the stability of stockpiles and the areas where stockpiles are placed. Contractor shall stockpile materials in a manner so as to not compromise the stability or cause loss of support to existing structures and surfaces.

4.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, vapor barrier installation, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

4.12 UTILITY TRENCH BACKFILL

A. Adhere to the requirements set forth in DC Water Standard Specifications.

4.13 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. The Contractor shall supply and place all fill materials necessary to bring the ground surfaces to the required levels.

C. All surplus materials shall be removed from site and legally disposed of. Should additional material be required for the placing of backfill, other than material obtained from the site, the Contractor shall obtain, deliver, and place accepted backfill material as required.

D. Fill shall not be placed against concrete elements until the concrete has obtained its specified compressive strength, unless otherwise directed by the Geotechnical Testing Agency and the Contractor.

E. Fill Placement:

1. Begin placement of fill and backfill at the lowest section of the area. Spread material evenly by mechanical equipment or by manual means above the approved compacted subgrade in lifts not exceeding 12-inches for material compacted by heavy machinery and 8-inches for material compacted by hand-operated compaction equipment.
2. Build layers as horizontally as practical to prevent thickness of lift from exceeding that specified but provide sufficient longitudinal and transverse slope to provide for runoff of surface water from every point.

F. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use non-structural soil material.
2. Under walks and pavements, use structural or engineered fill material.
3. Under steps and ramps, use structural or engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill or concrete.
 - a. Concrete must be used beneath foundations designed to bear on rock or decomposed rock.

G. Place soil fill on subgrades free of mud, frost, snow, or ice.

4.14 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.

4.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 10-inches in loose depth for material compacted by heavy compaction equipment, and not more than 8-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 1557:
 - 1. Under slabs-on-grade, spread footings, mat foundations, building slabs, steps, and pavements, designed to not bear directly on rock, 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 92 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 88 percent.
- D. For utility trenches, compact each layer of initial and final backfill soil material at 92 percent.

4.16 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 (matching existing grades for this project) 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 0.5-inch.

4.17 SUBBASE COURSES

- A. Place subbase course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course under pavements and walks as follows:
 - 1. Shape subbase course to required crown elevations and cross-slope grades.
 - 2. Place subbase course 6-inches or less in compacted thickness in a single layer.

3. Place subbase 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.
4. Compact subbase 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 D698.

4.18 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, water, debris, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs on-grade as follows:
 1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place drainage course 6-inches or less in compacted thickness in a single layer.
 3. Place drainage 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.
 4. Compact each layer of drainage course to required cross sections and thicknesses with a minimum of four passes with a plate-type vibratory compactor.

4.19 FIELD QUALITY CONTROL

- A. Geotechnical Testing Agency: The Contractor shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades of each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Testing agency shall test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 6938, and ASTM D 2937, as applicable. Tests shall 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 2150-ft² or less of paved area or building slab, but in no case fewer than 3 tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100-ft or less of wall length, but no fewer than 2 tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 160-ft 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.

4.20 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 the Contractor; 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.
- 4.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS
- A. Disposal: Remove waste material, including unsatisfactory soil, trash and debris and legally dispose of it off the Owner's property.
 1. Contractor to notify Owner of any surplus satisfactory soil. The owner may elect to store surplus satisfactory soil in designated storage areas on the Owner's property. Contractor to then stockpile or spread soil as directed by Owner.

END OF SECTION 31 2000

SECTION 32 1313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Curbs and gutters where applicable.
 - 2. Walkways.
- B. Related Sections:
 - 1. Section 312000 "Earth Moving" for fill material, unbound aggregate subbase and base courses.
- C. References:
 - 1. All material and installation shall comply with applicable District and National codes including the following:
 - a. Smithsonian Facilities Design Standards Latest Edition.
 - b. National Park Service, National Mall and Memorial Parks (NAMA) Standards.
 - c. District of Columbia Department of Transportation (DDOT) Standards and Specifications for Highways and Structures 2013 or Latest Edition.
 - 2. In the case where two codes differ on the same topic, the more stringent requirements shall be followed subject to approval by the Smithsonian Institute.

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. w/cm: The ratio by mass of water to cementitious materials.

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project Site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Exposed aggregate pavement methods
 - c. Quality control of concrete materials and concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mixed concrete manufacturer.
 - d. Concrete paving Subcontractor.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated. Include technical data and tested physical and performance properties.

- B. Design Data: For each type of product indicated.
 - 1. Concrete Mix Design
 - a. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Test Reports: For each type of product indicated.
 - 1. Aggregate Tests.
 - 2. Concrete Slump Tests.
 - 3. Air Content Tests.
 - 4. Flexural Strength Tests.
 - 5. Cementitious Materials.
 - 6. Field quality-control reports.
- D. Material Certificates: Signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.
- E. Qualification control testing reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 9 requirements for production facilities and equipment.
 - 1. Manufacturer must be acceptable to the National Park Service and the Smithsonian Institution.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.
- E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.
- G. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
 - 2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm).

1.6 PRE-CONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.7 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of no less than 50 deg F (10 deg C) and no more than 80 deg F (27 deg C) 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 design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 305.1 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in 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, and dry areas.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete Pavement: The following materials shall conform to the requirements of the DDOT "Standard Specifications," Division 500.
 - 1. Cementitious materials and aggregates.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or adhesive.
 - 8. Joint fillers.
- B. Concrete Sidewalk: Comply with the requirements of the National Park Service standards and specifications for exposed aggregate sidewalks and the details provided with the Construction Documents. Inform the Engineer of any conflicting specifications prior to pour.

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 of 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 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of normal-weight concrete determined by either laboratory trial mixes in accordance with the DDOT "Standard Specifications," Division 500 for pavements and Division 600 for sidewalks and National Park Service standards and specifications.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
 - 1. Do not use Owner's field quality-control testing agency as the independent testing agency.
- C. Proportion mixes to provide concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 2 1/2-3 1/2 inches.

2.4 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

2.5 EXPOSED AGGREGATE CONCRETE PAVING

- A. Aggregate to be supplied by a single approved gravel pit for duration of project. There shall be no shale in the aggregate mix.
- B. All sidewalk improvements or modifications to be coordinated with the National Park Service and the Smithsonian Institution.
- C. A mock-up to ensure matching is required for all projects. Contractor to coordinate with the Smithsonian Institution, Architect, and National Park Service. See Part 1 1.5.G of this specification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle to 3 mph.

2. Correct subbase with soft spots and areas of pumping or rutting exceeding a depth of 1/2 inch according to Division 31 Section EARTH MOVING.

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. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

3.5 JOINTS

- A. General: Construct 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.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, 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 the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements of the DDOT "Standard Specifications," Divisions 500 and 600.

3.7 CONCRETE FINISHING

- A. General: Finish in accordance with the requirements of the DDOT "Standard Specifications," Divisions 500 and 600, Smithsonian Institute Design Standards, and the National Park Service standards and specifications as applicable.

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 follow recommendations in ACI 305R for hot-weather protection during curing.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Test results shall be reported in writing to Architect, 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, specified compressive strength at 28 days, concrete mixture proportions and materials, compressive strength, and type of failure for both 7- and 28-day tests.
- C. Nondestructive Testing: Rebound hammer, ultrasonic, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- D. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that sump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- E. Concrete paving will be considered defective if it does not pass tests and inspections.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- G. Prepare test and inspection reports.

3.10 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving no more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

SECTION 32 1540 – CRUSHED STONE SURFACING

PART 1 -GENERAL

2.1 RELATED DOCUMENTS

- A. Drawings and contract clauses of the Construction Contract, including referenced Federal Acquisition Regulation (FAR) and Division-01 Specification Sections, apply to this Section.

2.2 SUMMARY

- A. This Section specifies all requirements necessary to furnish and install stabilized crusher fines surfacing for restoration of the existing gravel paving at disturbed areas of the site in accordance with National Park Service (NPS) requirements. Work includes:
 - 1. Production, stockpiling, hauling, placing, and compacting of surfacing materials as indicated on the drawings and specified herein.

2.3 RELATED WORK

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced pedestrian boardwalk system.
 - 1. Division 01 Section “Temporary Tree Protection” for gravel surfacing within the critical root zones of existing trees.

1.3 SUBMITTALS

- A. Samples: Provide three (3) samples of surfacing mixture in one quart clear plastic bags.

SECTION 2 PRODUCTS

2.1 SURFACING MATERIALS

- A. Basis of Design: The supply a minimum 4” of the crushed stone surfacing materials is based upon the “National Mall” mixture available from Stancills, Inc., Perryville, MD.
 - 1. Subject to compliance with requirements indicated on the drawings and specified herein, provide product systems from the named manufacturer, or comparable approved by the COTR and the National Park Service.

2.2 BASE COURSE MATERIALS

- A. Dense graded crushed stone base shall be furnished and installed as recommended by the surface mixture supplier to a minimum 6” compacted depth.

2.3 LEVELING COURSE MATERIALS

- A. Provide underlying leveling course using gravel and gravel mixtures as recommended by the surface mix supplier.

2.4 HERBICIDES

- A. Provide Casoron 4G granular weed and grass killer or COTR and NPS approved equivalent.

PART 3 – EXECUTION

3.1 GENERAL

- A. Equipment: Equipment used for compaction shall be the rolling type, vibratory type, or combination of both types, and shall be of sufficient capacity to meet the compaction requirements as recommended by the surface mix supplier and the NPS.

3.2 LAYOUT

- A. Stake or otherwise delineate the proposed alignment of the path according to the drawings. Obtain approval of the COTR and the NPS prior to proceeding with excavation and subgrade preparation.

3.3 PREPERATION

- A. Cut existing grade to a minimum of nine (9) inches deep or as shown on the drawings within limits of paving. Wet and roll subgrade to obtain a firm, uniform, compacted subgrade. Keep cut sides vertical and true to line horizontally with a uniform width.

3.4 WEED CONTROL

- A. Herbicide Application:
 1. Obtain written confirmation from surfacing mixture supplier prior to placing herbicide to ensure compatibility of proposed herbicide with approved surfacing mixture materials.
 2. Apply herbicide to prepared subgrade per manufacturer's recommendations.
 - a. Apply at a rate and strength, and by the method recommended by the manufacturer.
 3. Herbicides shall be applied using well-maintained equipment by individuals who are properly licensed by the governmental agency having jurisdiction over such applications.
 - a. It is the Contractor's responsibility to be knowledgeable of any and all laws and regulations pertaining to herbicide and other chemical applications, and to notify the COTR immediately if the application of products specified herein will be in violation of governing regulations.

4. Herbicides shall not be applied during periods when wind or other physical conditions cause the herbicides to be transported a distance of more than five (5) feet from the immediate area where they are being placed.

3.5 SUB-GRADE PREPARATION

- A. Base shall be a minimum of 6" thick and installed at 95% standard compaction on top of subgrade.
- B. Make any corrections necessary to prepared areas to bring the Base Course to the sections and elevations indicated on or derived from the information given on the drawings, or as needed to effectively transition with adjacent field conditions.
 1. Pre-soak base course with water prior to installing surfacing mixture.

3.6 PLACEMENT AND COMPACTION

- A. Do not install surfacing materials during rain or snow or on sub-grade that has standing water.
- B. Do not place surfacing materials at temperatures below 30°F unless first obtaining written approval from the surfacing mix supplier.
 1. At colder temperatures, surfacing mix may form clods. Allow clods to break apart on their own by warming the material in sunlight, or break up clods with machinery.
- C. Place surfacing mixture at a minimum 4" compacted depth.
 1. Achieve compaction using a 5-ton double drum roller
 2. Compact material making 8 to 10 passes
 3. Use plate compactor on edges and narrow areas that cannot be accessed using the roller.
 4. Loose material shall not be present on final surface.
- D. Watering:
 1. Water the area with a light spray following compaction taking care not to disturb the aggregate surface with the spray action.

3.7 INSPECTION

- A. Finished surface shall be uniform and solid, with no evidence of chipping or cracking
- B. Compacted surfacing shall be firm to the full depth of the paving assembly with no soft areas.
- C. Loose material shall not be present on the surface
- D. No ruts shall be visible on the surface of the pavement
- E. Repair unacceptable conditions repeating the procedures specified herein.

END OF SECTION 32 1540

SECTION 392900 - TURF

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and contract clauses of the Construction Contract, including referenced Federal Acquisition Regulation (FAR) and Division 01 Specifications Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sodding and planting soil.
- B. Related Sections:
 - 1. Division 01 Section "Temporary Tree Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
 - 2. Division 31 Section "Earthwork" for excavation, filling and backfilling, and rough grading.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. NPS: National Park Service
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- H. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- I. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- J. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Manufacturer's Product Data and Material Safety Data Sheets: For each type of product indicated. Provide four (4) weeks before installation of soil/media.
 - 1. Fertilizer(s).
 - 2. Limestone.
 - 3. Soil Acidifier.
 - 4. Coarse Sand.
 - 5. Compost (include pH).
 - 6. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- B. Samples for Verification: Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Delivered materials shall closely match the sample. Provide four (4) weeks before installation of soil for each of the following labeled containers:
 - 1. 1 liter of each source of topsoil (salvaged, imported, manufactured) to be used.
 - 2. 1 liter of each Soil Mix (Planting Soil).
 - 3. 1 liter of each organic material (compost).
 - 4. 1 liter of coarse sand
- C. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging. Provide four (4) weeks before installation of turf.
 - 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- A. Installer Qualifications: The installer shall be a firm with at least 5 years of successful experience in work similar in material, design and extent to that indicated for this Project and with a record of successful landscape establishment. Provide four (4) weeks before installation of turf.
 - 1. Installer's Field Supervision: Installer shall maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Qualification Data: For qualified Soil-Testing Laboratory. Include documentation that the Soil-Testing Laboratory is recognized by the State Department of Agriculture to conduct the testing

indicated and is qualified to conduct the types of tests to be performed. Provide four (4) weeks before installation of turf.

- C. **Product Certificates:** For manufactured products listed below, from manufacturer, stating that the manufacturer's product complies with this Section. Provide four (4) weeks before installation of turf.
 - 1. Fertilizer(s).
 - 2. Limestone.
 - 3. Soil Acidifier.
 - 4. Course Sand.
 - 5. Compost (include pH).
 - 6. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- D. **Material Test Reports:** For standardized ASTM D 5268 topsoil, existing in-place surface soil and imported or manufactured topsoil. Provide four (4) weeks before installation of turf.
- E. **Maintenance Instructions:** Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods. Provide four (4) weeks before installation of turf.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified landscape Installer whose work has resulted in successful turf establishment.
 - 1. **Professional Membership:** Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. **Experience:** Five years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
 - 3. **Installer's Field Supervision:** Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. **Personnel Certifications:** Installer's field supervisor during installation and maintenance shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation and maintenance specialty areas, designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
 - 5. **Maintenance Proximity:** Not more than two hours' normal travel time from Installer's place of business to Project site.
 - 6. **Pesticide Applicator:** State licensed, commercial.
- B. **Soil-Testing Laboratory Qualifications:** An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. **Soil Analysis:** For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content;

cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of two (2) representative samples shall be taken from each of the four (4) courtyard quadrangle areas proposed for sod installation for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D.** Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination" with COR, general contractor, all subcontractors, and owner's representative attending. This conference can occur simultaneously with the "Plants" or "Soils" conference.

1.6 DELIVERY, STORAGE, AND HANDLING

- A.** Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B.** Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C.** Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

- A.** Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 1 to April 20.
2. Fall Planting: August 1 to October 20.

- B.** Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.8 MAINTENANCE SERVICE

- A.** Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Sodded Turf: 30 days from date of planting completion.

PART 2 -PRODUCTS

1.1 TURFGRASS SOD

- A.** Turfgrass Sod: All sod species, and cultivars, whether cool or warm season, shall be from approved list found on University of Maryland/Virginia Tech turfgrass sites for the NCR region.

- B.** Turfgrass Species: Sod of grass species as follows:

1. General Material Requirements:

- a. Certified Turf Type Tall Fescue Sod: Shall be grown from a 90% mixture of one or more varieties of tall fescue seed, and 10% Kentucky bluegrass seed.
- b. Certified Bermudagrass Sod: Shall be grown from 100% Bermudagrass whether vegetatively or through seed.
- c. Certified Kentucky Bluegrass Sod: Shall be grown from a 100% mixture of three or more cultivars of Kentucky Bluegrass seed.
- d. Certified Zoysia Sod: Shall be grown from 100% Zoysia whether vegetatively or by seed.
- e. Contractor to provide sod varieties requested by COR.
- f. Sod shall meet the certification requirements published by the extension services of the University of Maryland or Virginia Polytechnic Institute and State University.
- g. Submit sod certification for species and location of sod source.
- h. Each load of "Certified Sod" or "Certified Turf" shall be accompanied by, in the same vehicle, an official certification label and that label shall be attached to a dated invoice, bill of lading or labeling information document.
- i. It is imperative that Contractor ensure that sod source selection matches as closely as possible soil structure, in consultation with the COR, to area to be worked upon. If it is determined that Contractor did not follow this mandate than all sod shall be removed and replaced at Contractor expense to an appropriated sod source matching soil structure of area to be worked upon as determined by the COR.
- j. Sod shall be harvested and delivered within a period of 24 hours and kept moist until placement.

- k. If sod is shipped with exterior (wrapped) netting, all netting must be removed prior to installation.
 - l. Any sod that is to be shipped or delivered during the period between June 1 and September 1 shall be shipped during periods of darkness and cooler temperatures, generally defined as between 12 midnight and one hour after sunrise. During these periods sod trucks shall be covered with tarps to prevent drying of the sod.
 - m. Sod shall be free of weeds and other grasses especially *Poa Annua*, fresh and moist. Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted. Sod shall not have excess thatch that will interfere with watering or use of the sod.
 - n. The COR may inspect the sod source prior to acceptance of the specific field as an approved source.
 - o. The sod shall be sufficiently knitted together such that a three-foot section of sod holds together when held off the ground from one end.
 - p. All equipment used on top of the soil, or on previously seeded or sodded areas shall be equipped with low pressure flotation type tires or track equipment. All such equipment shall be rated by the manufactures as having a maximum ground pressure of 8 PSI.
2. Standard Cut Sod (Slabs):
- a. Sod shall be machine cut at uniform soil thickness of 3/4 inch, +/- 1/4 inch, excluding top growth and thatch. Individual pieces shall be at least 18 inches wide and of length such that each piece is at least 1/2 square yard. Maximum allowable deviation from standard width is 5 percent.
 - b. Each piece of sod must be strong enough to support its own weight and retain its size and shape when suspended vertically from a firm grasp on the upper 10 percent of the piece.
 - c. Broken pieces and torn or uneven ends will not be accepted.
3. Rolls (Small or Large):
- a. Sod a minimum 1/4 inch thick plus the thickness of top growth and thatch.
 - b. The tolerance for sod thickness shall be plus 0.25 inches and minus 0.10 inches of the specified sod thickness.
 - c. Sod shall be cut at a min. of 42 inches wide and delivered in large rolls 62 feet long for 1/4-inch-thick sod. Split width rolls of sod are permitted on the perimeter of the sodded area as needed to accommodate the specific dimensions of the area.
4. Thick Cut:
- a. Sod shall be machine cut at uniform soil thickness of 1 1/2" to 1 3/4" thick, excluding top growth and thatch. Individual rolls shall be at least 40 inches wide and of length determined by roll weight. Maximum allowable deviation from standard width is 5 percent.
 - b. Broken pieces and torn or uneven ends will not be accepted.

1.2 INORGANIC SOIL AMENDMENTS

- A. Chemical materials designed to increase soil fertility. All material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All

products shall be freshly manufactured and dated for the season in which the products are to be used. Apply additives in amounts recommended in soil reports from a qualified soil testing agency..

1. Fertilizer for planting shall be an organic fertilizer.
 - a. Basis of Design Product: Plant Tone by Espoma Company (856) 825-0542, organic bone meal.
 - b. Fertilizer selections shall be based on the recommendations of the soil tests.
 - c. Specialty fertilizers and additives noted below shall be used where required by the specifications prior to the use of any additional fertilizer.
2. Soil Acidifier for reducing the pH of soil where fertilizer is not required.
 - a. Basis of Design Product: Espoma Soil Acidifier by Espoma Company (856) 825-0542 or approved equal.
3. To increase soil pH use a high quality agricultural ground limestone product with a calcium carbonate equivalent (CCE) of 100. Limestone selections shall be based on the recommendations of the soil test.

B. Sand: Coarse concrete sand, ASTM C-33 Fine Aggregate, with Fines Modules Index of 2.8 and 3.2.

1. Sands shall be clean, sharp, natural quartzite sands free of limestone, shale and slate particles. Sand pH shall be between 5.5 and 7.0.
2. Provide the following particle size distribution:

<u>Sieve Size:</u>	<u>Percent Passing</u>
3/8" (9.5mm)	100
No 4 (4.75mm)	95-100
No 8 (2.36mm)	80-100
No 16(1.18mm)	50-85
No30 (.60mm)	25-60
No50 (.30mm)	10-30
No100 (.15mm)	2-10

1.3 ORGANIC SOIL AMENDMENTS

A. Compost: Compost shall meet the requirements of the US Composting Council “CORure/Design Specifications for Compost Use”, section “Compost as a Landscape Backfill Mix Component”, with the following additional requirements:

1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch (12.5-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - a. Organic Matter Content: 50 to 60 percent of dry weight.
 - b. Compost feedstock shall be yard waste trimmings and/or source-separated municipal solid waste to produce a fungi-dominated compost. Compost shall not be derived from biosolids or industrial residuals.

1.4 PLANTING SOILS

A. Planting Soil: Imported Topsoil or Manufactured Topsoil Blend Planting Soil off-site in appropriate weather condition only. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
2. Blend chemical amendments, if required, with Topsoil at rates recommended by soil Testing Agency following amendment manufacturer's recommendations for use.
3. Thoroughly blend the following components in the proportions indicated below to produce Planting Soil:
 - a. 70% Amended Topsoil
 - b. 20% Course Sand
 - c. 10% Compost

1.5 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

1.6 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 -EXECUTION

1.7 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B.** Proceed with installation only after unsatisfactory conditions have been corrected.
- C.** If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

1.8 PREPARATION

- A.** Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect grade stakes set by others until directed to remove them.

1.9 TURF AREA PREPARATION

- A.** Limit turf subgrade preparation to areas to be planted.
- B.** Newly Graded Subgrades: Loosen subgrade to a minimum depth of 8 inches (200 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
 - 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.
 2. Spread planting soil to a depth of 8 inches (200 mm) 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 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C.** Unchanged Subgrades: If turf is 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 6 inches (150 mm). Apply soil amendments according to planting soil mix proportions and mix thoroughly into top 4 inches (100 mm) of soil. Till soil to a homogeneous mixture of fine texture.

3. Remove stones larger than 1 inch (25 mm) 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 (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future. All finish grades of turf areas shall be set below abutting pavements to allow for surface of turf to meet flush with abutting pavements.
- E.** Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F.** Before planting, obtain COR's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

1.10 SODDING

- A.** Phase the work to reduce the number of vehicular passes over any one area of the work.
- B.** Soil should be moist, but not wet, prior to laying sod.
- C.** Sod shall not be laid until the prepared sod bed has been approved by COR.
- D.** Lay sod within 24 hours from time of stripping and within 8 hours of arrival to the site. Protect any sod stored on site from damage due to weather. Do not lay sod on frozen ground. Do not store sod on the prepared planting soil or directly on paved surfaces. Protect from excess heat or drought by maintaining the soil in a moist state.
- E.** Sod shall not be laid during unfavorable conditions to successful completions. This is to include freezing weather, when the sod or ground is frozen, or when the sodding areas are too wet or too dry. COR shall make this determination.
- F.** Sod shall be placed by hand or mechanically with close joints.
- G.** Sod shall be patched in as required though the use of a straight edge sod shovel or the preferred method of a reciprocator. Machete patching is strictly prohibited.
- H.** Sod shall be installed smooth and flush with adjoining paving and transition smoothly to existing grass areas. Assure that the top of the sod thatch line is flush with the top of all adjacent curbs or other structures within or adjacent to the sodded areas.
- I.** Lay sod to form a solid mass with tightly fitted joints.
- J.** Butt ends and sides of sod strips.
- K.** Stagger strips to offset joints in adjacent courses.

- L. Fill all visible seams between sod pieces less than one inch wide, with planting soil flush to the that line of the sod.
- M. Fill all joints one inch or wider with cut pieces of sod.
- N. Sod shall be taken up and the installation repeated if sod workmanship is not satisfactory, as directed by the COR. This shall be solely at Contractors expense.
- O. Sod shall be thoroughly watered immediately after installation to a depth of 4 inches.
- P. After sod and soil have dried sufficiently to prevent damage, sod shall be rolled to ensure good bondage between sod and soil and remove minor depressions and irregularities. Tamp or roll lightly to ensure contact with sub grade. Work sifted soil into minor cracks between pieces of sod and remove excess soil to avoid smothering of adjacent grass. Sod shall be rolled perpendicular to the lying axis of the sod roll, with a standard turf roller, not to exceed 375 lbs. in weight, after an initial watering to eliminate irregularities.
- Q. The contractor shall adjust the water applications to reflect actual turf and weather conditions.
- R. The sod will then be lowered with two mowing's to 3.5 inches. Length of time needed for this will vary during the season as will water requirements.
- S. Sod will be watered and cared for until the sod has been rooted (cannot be pulled up) and sod grass height is grown to 4 inches.

1.11 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Operate irrigation system to keep turf uniformly moist to a depth of 4 inches (100 mm).
 - 1. Schedule watering to prevent wilting and puddling.
 - 2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 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 initial and subsequent mowings to maintain the following grass height:

1. Mow turf-type tall fescue to a height of 2 to 3 inches (50 to 75 mm).

1.12 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

1.13 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

1.14 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

END OF SECTION 32 2900

SECTION 32 3119 - 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 fences.
 - 2. Coordination with the COTR for swing gates furnished and installed by the Smithsonian and integrated into the fencing provided by the Contractor.
- B.** Related Sections:
 - 1. Division 03 Section "Cast-in-Place Concrete" for concrete footings.
 - 2. Division 31 Section "Earth Moving" for site excavation, fill, and backfill where decorative metal fences and gates are located.

1.3 PERFORMANCE REQUIREMENTS

- A.** Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 SUBMITTALS

- A.** Product Data: For each type of product indicated including hardware.
- B.** Shop Drawings: For fence and gates. Include plans, elevations, sections, details, and attachments to other work.
- C.** Samples: For each fence material and for each color specified.
 - 1. Provide Samples 12 inches in length for linear materials.
 - 2. Provide Samples 12 inches square for bar grating and sheet or plate materials.
- D.** Welding certificates.
- E.** Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for decorative metallic-coated steel tubular picket fences, including finish, indicating compliance with referenced standard.
- F.** Maintenance Data: For gate operators to include in maintenance manuals.

1.5 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."
- C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Include 10-foot length of fence complying with requirements with gate as part of mockup.
 - 2. Do not continue with Work until mockup has been approved by landscape architect.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 STEEL AND IRON

- A. Steel and Iron shall have a recycled content of 50 to 100%.
- B. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- D. Tubing: ASTM A 500, cold formed steel tubing.
- E. 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.
- F. Uncoated Steel Sheet: cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50.
- G. 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.

2.2 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section "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 and specifically recommended by manufacturer for exterior applications.

2.3 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: Copper.
 - 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.

2.4 DECORATIVE STEEL FENCES

- A.** Posts: Square 2" by 2" inch steel tubes as indicated.
- B.** Post Caps: Formed from fitted steel plate to simulate posts fabricated from solid steel bar.
- C.** Rails: Steel bars.
 - 1. Top: Rectangular steel bars 1 1/2" by 4/3" or as otherwise indicated on the drawings.
 - 2. Bottom: Same as top rail.
- D.** Pickets: 1/2-inch- round steel bars as indicated.
 - 1. Extend pickets beyond top rail as indicated on drawings including:
 - a. Mill ends to pyramid shaped points or
 - b. Create loop between two pickets over picket with pyramid point.
 - 2. Picket Spacing: As indicated on the drawings.
- E.** Fabrication: Assemble fences into sections by welding pickets to rails.
 - 1. Assemble fence sections to be readily demountable using semi-concealed fasteners connecting fence sections to mounting tabs welding to posts. Detail connection to accommodate the geometry of the segmentation angles.
- F.** Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.
- G.** Finish: Powder coating.

2.5 SWING GATES

- A.** Swing gates shall be furnished and installed by the Smithsonian's other contractor and are intended to be fabricated using same materials and finishes as specified herein.

2.6 STEEL FINISHES

- A.** Surface Preparation: Clean surfaces according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."

1. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B.** Powder Coating: Immediately after cleaning, apply 2-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils. Comply with coating manufacturer's written instructions.
 1. Color and Gloss: Black Matte.

PART 3 - EXECUTION

3.1 EXAMINATION

- A.** Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B.** Do not begin installation before final grading is completed unless otherwise permitted by Landscape 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. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
 1. Construction layout and field engineering are specified in Division 01 Section "Execution"

3.3 DECORATIVE FENCE INSTALLATION

- A.** Install fences by setting posts as indicated and fastening sections to posts.
- B.** Post Setting: Set and secure posts in recessed anchorages provided by and integrated within the boardwalk system. Refer to Division 32 Section "Custom Fabricated Pedestrian Boardwalk System".
 1. Coordinate with Section 323416 system engineer for the sizing of fence anchorages and method for securing fence posts.

3.4 GATE INSTALLATION

- A.** Swing gates shall be furnished and installed by the Smithsonian's other contractor and are intended to be fabricated using same materials and finishes as specified herein.

3.5 ADJUSTING

- A.** Gates: Assist gate installer in the adjustment of gates to operate smoothly, easily, and

quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 32 3119

SECTION 32 3416 – CUSTOM FABRICATED PEDESTRIAN BOARDWALK SYSTEM

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and contract clauses of the Construction Contract, including referenced Federal Acquisition Regulation (FAR) and Division-01 Specification Sections, apply to this Section.

1.2 SUMMARY

- B. This Section specifies all requirements necessary to furnish and install a custom fabricated pedestrian boardwalk system including, but not limited to the following:
 - 1. Structural steel framework with supports.
 - 2. Thermally modified lumber decking.
 - 3. Priced options for alternate decking materials
 - 4. Fittings, accessories and fasteners.

1.3 RELATED WORK

- C. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced pedestrian boardwalk system.
 - 1. Division 01 Section “Temporary Tree Protection” for required root investigation prior to commencing with design.
 - 2. Division 03 Section “Cast-in-Place Concrete” for concrete abutments.
 - 3. Division 06 Section “Miscellaneous Exterior Rough Carpentry” for sleepers, nailers and grounds.
 - 4. Division 32 Section “Decorative Metal Fences” for integrated fence anchors.

1.4 REFERENCES

- D. Refer to Manufacturer’s published literature for technical data, design requirements and additional information.

1.5 SUBMITTALS

- A. Product Data and SDS: For all materials, products, coatings and adhesives specified herein.
- B. Shop Drawings: Show fabrication and installation details for all components of the steel frame walkway and deck system. Include plans, elevations, sections, and details of metal fabrications and their connections. Show footing, supports, anchorage and accessory items.
- C. Delegated-Design Submittal: Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Qualification Data: For qualified professional engineer.
- E. Welding certificate and continuity logs.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the American Welding Society (AWS) standards:
1. AWS D1.1, "Structural Welding Code - Steel."
 2. AWS D1.2, "Structural Welding Code - Aluminum."

1.7 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports and framework for boardwalk platforms, pan footers, augured supports, rails, abutments, fence anchorages, and other system elements as identified by the system fabricator, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Boardwalk system shall withstand the effects of loads and stresses within limits and under conditions as specified in the following:
1. Applicable Codes and Standards:
 - a. Vibration and vehicle loads not required.
 - b. 2024 International Building Code.
 - c. ASCE 7 – Latest edition published by the ASCE
 - d. AISC ASD 14th Edition Steel Construction Manual
 2. Design Loads:
 - a. Dead Load:
 - i. Decking: 6.0 PSF
 - ii. Infill Framing: 30 PSF
 - iii. Perimeter Framing: 30 PSF
 - iv. Collateral: 30 PSF
 - b. Surface Live Load:
 - i. Walkway: 100 PSF
 - ii. No vehicle loading required.
 - c. Design Snow: As required by IBC
 3. Maximum Live Load Allowable Deflection Criteria: $L/360$ Live Load
 4. Temporary Loads:
 - a. The Contractor is responsible for limiting the amount of construction load imposed upon structural framing. Construction loads shall not exceed the design capacity of the framing at the time the loads are imposed.
 - b. The structure is intended and expected to be designed to function as a unit upon completion. The Contractor is responsible for designing and furnishing all temporary bracing and/or support that may be required as the result of the Contractor's construction methods and/or sequences.
 - c. The Contractor is responsible for providing engineering analysis and certification for temporary loading conditions that fall outside of the those specified above.

- C. Thermal Movements: Allow for thermal movements for ambient and surface temperatures changes acting on metal fabrications and on deck materials by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects.

1.8 PROJECT CONDITIONS

- A. Field Measurements and Root Investigation: Verify actual locations of roots within the critical root zones of the existing trees and utilize location data for the coordination of support locations before preparing shop drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements.
 - a. Provide allowance for deconflicting support points and existing roots with adjustable fitting at site.

1.9 COORDINATION

- A. Coordinate installation of fence anchors and steel weld plates, bearing plates and angles for casting into concrete. 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.

1.10 WARRANTY

- A. Provide warranty against defects and workmanship for a period of ten (10) years from date of original shipment.

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents. from date of original shipment.
 - 1. Quantity: Furnish 100 linear feet of 5/4x6 deck material in lengths of not less than 8' and 20 linear feet of 4/4x6 deck material in lengths of not less than 8'.

SECTION 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: The supply of the Custom Fabricated Pedestrian Boardwalk System is based upon the custom design and fabrication capabilities available from Wickcraft Boardwalks, Madison, WI.
- B. Subject to compliance with requirements indicated on the drawings and specified herein, provide product systems from the named manufacturer, or comparable system by the following:
 - 1. Custom Bridges and Boardwalks, Clinton, WI.
 - 2. Modular Trail Structures, Madison, WI.
 - 3. Another manufacturer acceptable to COTR.

2.2 METALS, GENERAL

- 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.

2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: American Society for Testing and Materials International's (ASTM) Standard A 36.
- B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- C. Steel Pipe: ASTM A 53, standard weight (Schedule 40) unless otherwise indicated.
- D. Steel Rods: ASTM F 1554, Grade 36 unless otherwise indicated.
- E. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240 or ASTM A 666, Type 304.
- F. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

2.4 FASTENERS – METAL FRAMEWORK

- A. General: Unless otherwise indicated, provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency
- C. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot dip galvanized per ASTM F 2329.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

2.5 MISCELLANEOUS MATERIALS – METAL FRAMEWORK

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat and equal to Tnemec-Zinc 90-97.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.6 DECK MATERIALS

- A. Basis of Proposal – Thermally Modified Wood

1. Basis-of-Design: Kebony™ Clear Radiata #2522, 5/4x6 (nominal) by Kebony AS, Tel: 855.230.5656, info@kebony.us, www.kebony.us **or equal**
2. Moisture Content:
 - a. Moisture content of 4 to 8 %
3. Surface:
 - a. Edges shall be eased to a radius of 3.5mm.
 - b. Knots/Pitch pockets: Select lumber to limit occurrences to no more than one instance of each per board.
 - c. Cupping: Max 1 % of width.
4. Dimensions on Drawings: Nominal and Actual Size shall be listed.
5. Length:
 - a. Lumber shall be supplied at or over specified length for final fit in the field.
 - b. Lumber shall be supplied precision trimmed to specified lengths as indicated on the drawings.

Other known manufacturers are:

B. Thermally Modified Wood – Alternative Source

1. Provide thermally modified wood materials from the following alternative source: Furnish products by ThermoryUSA, www.thermoryusa.com.
 - a. Species: White Ash.
 - b. All other technical characteristics: Generally comparable to the Basis of Proposal product specified above.

C. Thermally Modified Wood – Alternative Source

1. Provide thermally modified wood materials from the following alternative source: Furnish Accoya Acetylated Wood products by ACCSYS Technologies PLC.
 - a. Species: White Ash.
 - b. All other technical characteristics: Generally comparable to the Basis of Proposal product specified above.

D. Alternate - Wood-Plastic Composite:

1. Material Description: Composite decking consisting of recycled Linear Low-Density Polyethylene (LLDPE) and recycled wood
2. The supply of the Wood-Plastic Composite Materials is based upon “Trex Signature” manufactured by Trex Company, Inc., Winchester, VA.
3. Physical Characteristics:
 - a. Nominal Dimensions: 5/4 x 6
 - b. Actual Dimensions: 0.94” x 5.5”
 - c. Edge Profile: Grooved
 - d. Lengths: 12-ft, 16-ft, 20-ft.
 - e. Weight: 2.4 lbs. per linear foot

2.7 FASTENERS – DECKING

- A. Description: Self-gapping, glass-filled nylon fasteners with 304 grade stainless steel sharp point screw for wood framing, or as otherwise recommended by the decking manufacturer for installations where the appearance of fasteners in to be minimized while also permitting easy replacement of individual boards.

2.8 ROUGH CARPENTRY

- A. Refer to Division 06 Section “Miscellaneous Exterior Rough Carpentry”.

2.9 ACCESSORY MATERIALS

- A. Drainage Mats: At pan footings resting on grade, provide heavy duty prefabricated drainage composite mat with compact profile.
 - 1. Description: provide impermeable high-flow dimpled polypropylene drainage core heat-bonded to a layer of woven polypropylene filter fabric on the top side and a polyethylene membrane protection film on the bottom side.
 - 2. Basis of Design: Provide “Drainage Mat 720” manufactured by Sika Corporation or comparable product with equivalent performance as approved by the COTR.
 - a. CBR Puncture: 850 lbs.
 - b. Thickness: 0.25”
 - c. Compression Resistance: 18,000 psf

2.10 FABRICATION

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- 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. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- H. All hollow enclosed steel members shall have weep holes as indicated by the system designer. Holes shall be located in the center of the shorter walls of rectangular tubes and placed to face the inside or away from public view when possible.

2.11 FINISHES, GENERAL

- A. Comply with National Association of Architectural Metal Manufacturer's (NAAMM) "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. To the greatest extent possible, steel framing members, connection plates, fasteners and anchor bolts shall have a hot-dip galvanized finish. Apply coating by the hot-dip process for galvanizing according to ASTM A 123.
1. When members are designed to fit into each other, the galvanizer shall galvanize and test-ft one set prior to galvanize all members.
- C. Steel components designed to be field-coated shall be galvanized by the "Dry Galvanizing Process" as defined by AGA (flux and galvanizing applied in separate steps). Galvanized members shall not be quench cooled.
- D. Any damaged galvanizing or un-galvanized material shall be primed with a zinc rich primer prior to painter per the manufacturer's recommendations.
1. Provide Tnemec Series 90-97 Tnemec Zinc @ 3.0-4.0 mils OFT or COTR-approved equal.

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. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of units that are for bolted or screwed field connections.
- C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

3.3 INSTALLING WOOD-PLASTIC COMPOSITE DECKING

- A. General: Install according to manufacturer's written installation instructions.
- B. Cut, drill, and rout using carbide-tipped blades.

3.3 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
- B. Wood-Plastic Composite Decking: Clean in accordance with the manufacturer's written recommendations.

END OF SECTION 32 3416