Lee's Summit Robotics, GiC & Phys Education

Project Manual
Volume 3 of 3

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multistudio

SECTION 270010 - GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and to all following sections within Division 27.

1.2 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 27 of these Specifications, and Drawings numbered with prefix TN, generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 ABBREVIATIONS AND ACRONYMS

A. ADA Americans with Disabilities Act

B. AFF Above Finished Floor

C. AHJ Authority Having Jurisdiction

D. ANSI American National Standards Institute

E. ASTM American Society for Testing and Materials

F. BICS Building Industry Consulting Service International

G.	ETL	Electrical Testing Laboratories, Inc.
H.	FCC	Federal Communications Commission
I.	FM	Factory Mutual
J.	GE	Grounding Equalizer
K.	IEEE	Institute of Electrical and Electronic Engineers
L.	LED	Light Emitting Diode
M.	NEC	National Electrical Code
N.	NESC	National Electrical Safety Code
O.	NEMA	National Electrical Manufacturers Association
P.	NFPA	National Fire Protection Association
Q.	NRTL	Nationally Recognized Testing Laboratory
R.	OEM	Original Equipment Manufacturer
S.	OFCI	Owner Furnished Contractor Installed
T.	OSHA	Occupational Safety and Health Administration
U.	OSP	Outside Plant
V.	RCDD	Registered Communications Distribution Designer
W.	TBB	Telecommunications Bonding Backbone
X.	TGB	Telecommunications Grounding Bus-bar
Y.	TIA	Telecommunications Industries Association
Z.	TMGB	Telecommunications Main Grounding Bus-bar
AA.	UL	Underwriters Laboratories
BB.	UON or UNO	Unless Otherwise Noted

1.4 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
2. Approved Equivalents or Equal - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their

bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.

3. As Directed - means as directed by the Contract Administrator, or his representative.
4. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.
5. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
6. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
7. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is "the Owner's Representative".
8. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Contract Administrator, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Contract Administrator".
9. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
11. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
13. Provide - "To furnish and install complete, and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
14. Submit - means submit to Contract Administrator for review.
15. Substitution - means a product meeting all requirements and specifications and having been approved by the Design Consultant to replace another product specifically identified herein.
16. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of "inside" premises cable.

    a. For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a "wet location."
    b. Also refer to the:

1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations

17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified".

C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.5 REFERENCE STANDARDS

A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them.

E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the latest revision or printing (UON):

1. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
2. NFPA 70 – National Electrical Code (NEC)
3. IEEE National Electrical Safety Code (NESC)
4. Americans with Disabilities Act (ADA) of 1990, as amended

1.6 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.

C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.

D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

G. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.

J. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.

K. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.

L. Measurements and Layouts: The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of

other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

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

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined whin these Specifications, provide dimensioned layouts of communications equipment locations within communications (telecom and AV) rooms, electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
3. Indicate path to allow the future removal of each large piece of equipment (including but not limited to communications racks and cabinets) without removal of nonrelated equipment or architectural elements.
4. Include work provided by others routed through the equipment rooms.

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

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where Henderson Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, Henderson Engineers makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

D. Refer to Coordination requirements in specific sections for additional information.

1.8 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Design Consultant that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Design Consultant's designated representatives. Contractor shall allow for the Design Consultant Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Design Consultant Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Design Consultant review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases:

1. Pre-bid

    a. Required no less than two weeks prior to the due date for the submission of bids, such as:

        1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
        2) Alternate personnel credentials to be reviewed for approval
        3) And as required by individual sections in this Division

2. Bid

    a. Required at the time of the submission of bids, such as:

        1) Bid Response Forms
        2) Unit Pricing (if required by sections in this Division)
        3) Personnel Qualifications
        4) Contractor Qualifications (Previous project references)
        5) Voluntary Bid Alternates
        6) And as required by individual sections in this Division

3. Pre-construction

    a. Required after the award of the project to the winning bidder and prior to starting construction.
    b. Submit the following items no longer than four weeks after receiving the notice to proceed:

        1) Division of Labor amongst sub-contractors. Include:

            a) Company Name
            b) Address
            c) Name of project manager for this project, including:

                i) E-mail
                ii) Telephone number

        2) Construction schedule showing important milestone dates and activities. Schedule shall be coordinated with overall project construction schedule.
        3) Updated Personnel and Contractor Qualifications where different from those submitted during the Bid phase.
        4) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
        5) Manufacturers' cut-sheets:

            a) Cut-sheets are to be in the same order as in the specification sections.
            b) At a minimum all cut-sheets shall contain the following:

                i) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance

ii) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo somewhere on the page
iii) All parts, pieces, and equipment submitted for review shall be clearly identified by stamp, markup, or highlight in such a manner that the product(s) being submitted are clearly identifiable and distinguished from all other materials, parts, or equipment that may be on the submittal.
iv) For cut-sheets with accessories, additional parts, or derivations of the product being submitted, all shall be clearly identified for the reviewer and acceptance.
v) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

6) Samples – refer to individual sections for specific sample requirements.

a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover all associated fabrication and shipping costs.

c. Submit the following items sufficiently prior to installation of each respective portion of work:

1) Shop Drawings

a) Shall be furnished per the requirements of each Division 27 specification Section.

4. Project Completion

a. Required after the substantial completion but prior to final approval for completion, such as:

1) Record Drawings
2) Operation and Maintenance Data
3) Project test reports
4) Cable Databases (as applicable)
5) Warranty Certificate(s)
6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.
7) And as required by individual sections in this Division

I. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

J. Refer to individual Sections for additional submittal requirements.

K. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.

L. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

M. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

N. The checking and subsequent acceptance by the Design Consultant and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Design Consultant and Contract Administrator prior to implementing any deviation.

1.9 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:

    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.

e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. Contact the Contract Administrator for written authorization.

D. The following must be received before electronic drawing files will be sent:

1. Contract Administrator's written authorization
2. Engineer's release agreement form
3. Payment

1.11 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.13 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.14 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these

drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

E. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

F. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

A. Refer to Division 1 and General Conditions for Temporary Facilities requirements.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1.18 FIELD CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the Site prior to submitting bid to determine the nature and extent of work involved.
2. Schedule Work in the existing building with the Owner.
3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves Communications systems, equipment, raceways, equipment supports or foundations and materials.
4. Remove articles that are not required for the new Work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
5. Relocate and reconnect Communications facilities that shall be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
6. Obtain permission from the Contract Administrator for channeling of floors or walls not specifically noted on the Drawings.
7. Protect adjacent materials indicated to remain. For Work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
8. Locate, identify, and protect Communications services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services shall be interrupted, provide temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.

B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.3 EXISTING UTILITIES

A. Existing utility services not specifically indicated to be removed or altered shall remain as they presently exist.

B. Where existing services interfere with demolition or construction, alter or reroute such existing equipment to facilitate demolition or construction after obtaining written permission from the Contract Administrator. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.

C. Schedule and coordinate with the utility company, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.

D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.

E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.

F. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.

G. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.

H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.4 WORK IN EXISTING FACILITIES

A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.

B. Schedule Work in the existing facility with the Owner.

C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves communications systems, conduit, wiring, equipment, equipment supports or foundations and materials.

D. Remove all of these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.

E. Interruption of Existing Communications Service: Do not interrupt communication service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary communication service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of communication service.
2. Do not proceed with interruption of communication service without Contract Administrator and the Owner's written permission.
3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.

F. Reconnect communication circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.

G. Relocate and reconnect all communications facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications devices or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.

H. Finish materials are specified in other divisions.

I. Where removal of existing wiring interrupts continuity of communication circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued communication continuity.

J. Channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all channeling not specifically noted on the Drawings.

3.5 PERMITS AND FEES

A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.

B. Pay royalties or fees in connection with the use of patented devices and systems.

3.6 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".

B. Maintain all code required clearances and clearances required by manufacturers.

3.7 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 27 Section "Common Work Results for Communications".

B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.8 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.

C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.

D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.

E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
2. Under building slabs, use drainage fill materials.
3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
5. Other areas use excavated or borrowed materials.

O. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids.
4. Removal of trash and debris.

P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less that 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.

Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.9 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.10 PAINTING

A. Refer to Division 09 Section "Painting" for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.11 CLEANING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.

C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

D. Touch up and restore damaged finishes to their original condition.

E. All communications equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

3.12 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all equipment furnished and/or installed under this Division.

B. Check and test protective devices for specified and required application, and adjust as required.

C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

E. Refer to individual Sections for additional and specific requirements.

3.13 START-UP OF SYSTEMS

A. Prior to start-up of each system, check all components and devices to confirm compliance with manufacturers' recommended installation procedures.

B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

C. Refer to individual Sections for additional and specific requirements.

3.14 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit results of systems tests and adjustments per each individual section.
2. Submit complete Operation and Maintenance Data.
3. Submit complete Record Drawings.
4. Perform all required training of Owner's personnel.
5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
6. Perform start-up tests of all systems.
7. Remove all temporary facilities from the site.
8. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.

B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of five (5) business days notice prior to the review for project sites within a 4-hour drive from the office where the design was created; provide a minimum of eight (8) business days notice for sites beyond a 4-hour drive.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.15 EARLY OCCUPANCY

A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.

1. Refer to individual sections for additional requirements.

B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements for Division 27 systems as follows:

1. Grounding and Bonding for Communications
2. Pathways for communications systems.
    a. Cable Supports
    b. Conduit
    c. Surface Raceways
    d. Outlet Boxes
    e. Pull Boxes
3. Firestopping Systems
4. Access Panels
5. Identification

1.2 RELATED REQUIREMENTS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in the following Sections: 27 Section "General Communications Requirements"

B. Division 07 Section "Penetration Firestopping" for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

C. Division 26 for reference regarding materials and methods for additional requirements.

D. Division 27 "General Communications Requirements"

1.3 DEFINITIONS

A. ASTM - American Society for Testing and Materials

B. AV – Audio Video

C. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.

D. Common Work – all Work specified in this section.

E. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.

F. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.

G. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.

H. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.

I. FM – Factory Mutual

J. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

K. IMC – Intermediate Metal Conduit

L. NEMA – National Electrical Manufacturers Association

M. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

N. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.

O. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.

P. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.

Q. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is either the Project RCDD, as defined in Division 27 Section "Structured Cabling System", for Common Work for Telecommunications.

R. RMC – Rigid Metal Conduit

S. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

T. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

U. UL – Underwriters Laboratory

1.4 REFERENCE STANDARDS

A. Follow all applicable codes, references, guidelines, and standards listed in Division 27 Section "General Communications Requirements".

B. Follow the additional codes, references, standards and guidelines:

1. NEMA VE 1-2017 – "Metallic Cable Tray Systems"
2. NEMA VE 2-2013 with 2016 Corrections – "Cable Tray Installation Guidelines"
3. ASTM E 814 and ANSI/UL1479 –"Fire Tests Through Penetration Firestops"
4. ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
5. ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"

1.5 ADMINISTRATIVE REQUIREMENTS

A. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication:

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

1.6 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements".

B. Bid Submittal

1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.

C. Pre-construction Submittal

1. Manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:

    a. In addition to Division 27 Section "General Communications Requirements", include the following:

        1) Size – including physical and loading dimensions
        2) Maximum span length
        3) Weight supported
        4) Type
        5) Fittings to be used
        6) Method of attachment to structure
        7) Firestop system assembly information for each system to be installed:

            a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:

                i) Firestop manufacturer
                ii) UL system number
                iii) F, T, and L Ratings
                iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

        8) As well as any additional information required by individual sections of this Division

2. Shop Drawings

    a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.

        1) Each pathway shall be identified by type and size on the drawings.

            a) Example #1: 4" EMT
            b) Example #2: 4" x 12" Cable Tray

        2) Each grounding conductor shall be identified by size (and insulation):

            a) Example: #3/0 insulated ground

        3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.

            a) Example #1 – Firestopping Sleeve:
            EZ-Path Series 22, UL System W-L-3255
            b) Example #2 – Backbox in Fire-Rated Wall:
            Specseal Power Shield, UL System QCSN/CLIV.R14288

        4) Each pullbox and access panel shall be identified by size and height above finished floor.

a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.

b. Unless otherwise required by these specifications, it is permissible to show pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing along with the cabling and system work to be installed through those pathways.

1) Division 271000 "Structured Cabling System" and Division 274100 "Audio Video Systems" and their individual pathways shall be separate shop drawings; shared pathways such as cable tray shall be shown on both shop drawings.

D. Project Completion Submittal

1. Record Drawings:

a. The Quality Control Specialist shall review the installation and Record Drawings for the Common Work Results required for their scope of work and shall stamp the final Record Drawings with their RCDD or CTS-I stamp before submission. By stamping the Record Drawings, the Quality Control Specialist indicates that the Common Work Results have been installed per the Contract Documents and all associated codes, standards, and guidelines, and all changes to the drawings have been incorporated into the Record Drawings.

1.7 QUALITY ASSURANCE

A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.

1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:

a. All applicable codes and industry standards and guidelines referenced in Division 27.
b. Being fully-coordinated with all other trades and to be installed per the Construction Documents.
c. And installed per manufacturer's direction.

B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.

1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.

C. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:

a. FM Research, approved in accordance with FM AS 4991.

b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.8 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The list below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants or sleeves.
   1. Offices

PART 2 - PARTS AND MATERIALS

2.1 GROUNDING AND BONDING FOR COMMUNICATIONS

A. Refer to drawings and Division 27 Sections "Telecommunications Equipment Room Fittings" for exact grounding and bonding requirements.

2.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. General

1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
3. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.

B. Cable Supports

1. The following manufacturers are Conditionally Approved.

   a. Cooper/B-Line
   b. Hilti
   c. Monosystems
   d. nVent Caddy
   e. Panduit
   f. Snake Tray
   g. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Metal Hook Supports ("J-hooks")

   a. Specifications

      1) Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations.
      2) Be open for easy lay-in and removal of cabling
      3) Be designed so the mounting hardware is recessed to prevent cable damage

4) Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3
5) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
6) Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions
7) Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed

b. Cable hooks for installation above ceilings shall be

1) B-Line series BCH21, BCH32, BCH64
2) Caddy CABLE-CAT 21 or 32 series hangers
3) Or equivalent from Conditionally Approved manufacturer

c. Cable hooks for installation below raised floor shall be

1) B-Line series BCH21, BCH32, BCH64 with appropriate underfloor support bracket
2) Snake Tray; Snake Hook series cable hooks
3) Caddy CABLE-CAT 21 or 32 series hangers with appropriate underfloor support bracket
4) Or equivalent from Conditionally Approved manufacturer

C. Conduit

1. Specifications

a. Refer to Electrical Division 26 for specific product and material information.

1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

b. Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.
c. If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated. Generally this connection point will be a designated Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.
d. Follow Electrical Division 26 for conduits underground, in slab or anywhere not within the building.
e. Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm) for structured cabling. Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications (Telecom), AV, TV, Broadcast, Intercom, etc.), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the

ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.

f. Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

Number of Structured Cabling Outlets/Connectors	Conduit Size
Up to 4	1 inch (25.4 mm)
Up to 9	1-1/4 inch (31.8 mm)

D. Acoustical Pathway

1. Specifications

a. For use in non-rated walls only.
b. For use in place of conduit sleeves through walls of noise critical spaces.
c. Plenum Rated (to UL2043)
d. Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.

2. Manufacturer shall be:

a. Hilti CS-SL SA
b. Specified Technologies, Inc. - NEZ33

E. Surface Raceways

1. The following manufacturers are Conditionally Approved.

a. Surface Metal Raceways

1) Hubbell
2) Legrand/Wiremold
3) Mono-Systems Inc.
4) Panduit
5) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Specifications

a. Refer to Electrical Division 26 for specific product and material information.

1) Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.

b. Raceways shall be sized per the quantity and size of the installed cables, plus 50% spare capacity. Minimum cross-sectional area shall be 1 inch.
c. Single gang and double gang surface boxes shall be a minimum of 2-1/2 inches deep.
d. Color shall be as directed by the Architect.

3. Manufacturer shall be:

a. Submit product cutsheet(s) from Conditionally Approved manufacturer listed above.

F. Outlet Boxes

1. Specifications

a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
b. Telecommunications – for outlets shown onT or TN series drawings:

1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s).

a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
b) RANDL T-55017; or
c) Or equivalent from

i) Emerson/Appleton
ii) Thomas & Betts/Steel City
iii) Approved Substitution

2) For ceilings (flush or above accessible ceiling): *plenum-rated*, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).

a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
b) Or equivalent from

i) Emerson/Appleton
ii) Thomas & Betts/Steel City
iii) Approved Substitution

3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.

a) Single gang – RACO 695
b) Double gang – RACO 696

4) Weatherproof: Aluminum die cast, weatherproof box with 1" conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches ddep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.

a) Single gang – Thomas and Betts – IHD3-3 or equivalent

i) Or equivalent from

(1) Emerson/Appleton

(2) Hubbell/RACO
(3) Approved Substitution

b) Double gang – Thomas and Betts – 2IHD5-3 or equivalent

i) Or equivalent from

(1) Emerson/Appleton
(2) Hubbell/RACO
(3) Approved Substitution

G. Pull Boxes – for interior use only

1. Specifications

a. NEMA 1
b. Refer to Execution section for sizing requirements.

2. The following manufacturers are Conditionally Approved.
a. NEMA Enclosures
b. Wiegmann
c. Or Equivalent

2.3 FIRESTOPPING SYSTEMS

A. General

1. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
2. The following manufacturers are Conditionally Approved.

a. Specified Technologies, Inc.
b. Hilti
c. Specified Technologies, Inc

3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications

a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
d. Allows the installation and removal of cables without the need to remove or add any materials.
e. Used to seal penetrations of cables through fire rated partitions
f. Not subject to the single manufacturer requirement

2. Manufacturer shall be:

    a. EZ-Path family of products by Specified Technologies Inc.
    b. Hilti Firestop Speed Sleeve CP 653 Series

C. Firestopping for Backboxes in Fire-Rated Walls

1. Specifications

    a. Used to seal backboxes in fire rated partitions.
    b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
    c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

2. Manufacturer shall be:

    a. Hilti CP 617 or CFS-P PA
    b. Specified Technologies Inc., SpecSeal Power Shield
    c. Or equivalent from Conditionally Approved manufacturer.

D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications

1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.
2. Specifications:

    a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

3. Manufacturer shall be:

    a. Hilti – submit UL System documention for each floor/wall type and product cutsheets for all Hilti materials to be utilized
    b. Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized
    c. Or equivalent from Conditionally Approved manufacturer.

2.4 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

A. Labels

1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.

    a. Brady
    b. Brother
    c. Dymo
    d. HellermannTyton
    e. Panduit
    f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Specifications:

    a. Refer to additional requirements in Part 3 – Execution.
    b. Refer to individual sections for additional identification requirements for specific work.

2.5 KEYS

A. Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

PART 3 - EXECUTION

3.1 PATHWAYS FOR COMMUNICATIONS

A. General

1. Refer to Electrical Division 26 for additional installation requirements.

    a. Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.

2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling when contractor performs conduit sizing calculations, otherwise follow conduit sizes indicated on drawings.
6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
8. Install all communications pathways:

    a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
    b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
    c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
    d. So that the maximum allowable pulling tension is not exceeded.
    e. To meet the requirements of the structure and the requirements of all other Work on the Project
    f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
    g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.

h. Parallel or perpendicular to building lines or column lines.
i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.

    a. Except when supported by ladder racking within each Telecommunications room, UON.

10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for communications cabling purposes. Any deviation from this will not be accepted.

    a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON
    b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON

11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).
13. Waterproofing

    a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
    b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

14. Cutting and Patching

    a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
    b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
    c. Patch around all openings to match adjacent construction.
    d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.

e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

15. Mounting Heights

a. Mounting heights for equipment and devices requiring operational acess shall conform to ADA requirements.

1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.

b. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
c. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

16. Painting

a. Refer to Division 9 Section "Painting" for painting requirements.
b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
f. Provide touch-up paint as required by Specification Sections in this Division.

17. Fastenings

a. Fasten equipment to building structure in accordance with the best industry practice.
b. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:

1) Wood: Wood screws.
2) Concrete and solid masonry: Bolts and expansion shields.
3) Hollow construction: Toggle bolts.
4) Solid metal: Machine screws in tapped holes or with welded studs.
5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.

c. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:

1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:

1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
f. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.
g. Bridle rings are prohibited for Division 27 cables, unless otherwise noted on drawings.

18. For large quantities of cables (greater than 50) that converge upon a common run such as at a rack, in corridors, and other areas, provide cable trays or other special supports that are specifically designed to support the required cable weight and volume.
19. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces

B. Access to pathways and associated equipment

1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.

a. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
b. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.

3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable distribution

1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:

    a. For typical new walls:

        1) Conduit from outlet location to accessible ceiling then j-hooks to main run of cable tray.

    b. For existing walls:

        1) For stud walls - "Ring and String": Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
        2) For masonry or inaccessible walls – Surface-mounted raceway to accessible ceiling space.

    c. For phone and data lines to all Elevator Equipment Rooms and Fire Alarm panels:

        1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.

    d. See drawings for clarification

D. Conduits

1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
2. Adequate access shall be available where cables enter conduits
3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607B – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
4. Install conduits in the most direct route possible, running parallel to building lines
5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
6. Conduits which enter Telecommunications rooms shall extend 3 inches (76.2 mm) AFF or through the wall.
7. Conduits which enter Entrance Facilities shall extend 4 inches (101.6 mm) AFF or below the finished ceiling (if exists).
8. Flexible conduits may only be used where specifically allowed by these contract documents.

    a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length.

9. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
10. For structured cabling, no more than (2) 90° bends, or equivalent will be allowed between pullboxes.

    a. Each and any offset shall be considered a 90° bend.
    b. A pullbox is required wherever a reverse bend is installed.

11. The minimum bend radius for conduits is

    a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
    b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).

12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.
13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.

    a. Coordinate with Contractor for Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling" for potential other pathways where IMC/RMC are required.

14. Conduits shall contain no electrical condulets (also known as LBs).

    a. Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.

15. Underground Conduit Requirements

    a. For Structured Cabling System horizontal cabling and pathways within the footprint of the building and serving voice and data outlets exterior to the building, such as emergency phones/towers, security cameras and wireless access points attached to exterior light poles, etc
    b. Requirements

        1) Refer to applicable details on drawings for illustrative requirements.
        2) Wherever practical, slab-on-grade floorboxes shall have conduit extended underground or in-slab from box to serving communications room or equipment cabinet.

            a) Only one horizontal bend is allowed, 90 degrees or less.
            b) Indicate proposed routing and stub-up locations on shop drawings.

        3) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.

            a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are not to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.

        4) Approved conduit types:

            a) When routed in slab-on-grade:

                i) Horizontal conduit shall be RMC or Schedule 40 PVC, including horizontal bends. If PVC is installed, also install tracer wire.
                ii) Vertical bends shall be RMC.

            b) When routed below slab-on-grade or outside the fooprint of the building:

i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
ii) All vertical and horizontal bends shall be RMC.

16. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
17. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.

   a. Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.

2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. PullBoxes

1. Pullboxes shall be placed in Conveniently Accessible locations.
2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
3. Pullboxes above an accessible ceiling shall:

   a. Be aligned directly over the ceiling grid to allow access
   b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles

4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size pullboxes according to the following chart (all sizes are minimums):

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
1" or smaller	4"	4"	2-1/8"	Not applicable
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	27"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	8"

G. Cable Tray

1. Cable trays shall be installed in accordance with the applicable electrical code and standards.

2. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
3. Cables shall remain unattached to its pathway and shall simply lay at rest on the supports provided by its pathway. Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
4. Installation of cables shall not exceed the fill requirements stated above.
5. Cable trays shall not extend through fire-rated walls and walls for noise critical spaces.
6. Cable trays shall not extend over 6' lengths (or greater) of inaccessible ceilings. Stop cable trays just before the inaccessible ceiling and provide overhead conduits of quantity and size bridging the two sections of cable tray so that conduit cable capacity (square inches per fill ratio) is equal to that of the cable tray.

    a. The cable fill ratio for cable tray shall be 50%.
    b. The cable fill ratio for conduits shall be 40%.
    c. Example: a 4" x 12" cable tray has 48 square inches of total capacity, and 24 square inches of cable capacity. Per the NEC, a 4" trade size EMT conduit has a 40% cable capacity of 4.62 inches. 24 divided by 4.62, rounding up to the next whole number equals (6) 4" conduits shall be provided for a 4" x 12" cable tray.

7. Cable trays and cable runways shall not be used as walkways or ladders.
8. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
9. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access.
10. Basket cable trays shall be supported according to manufacturer's instruction via one of the following:

    a. Trapeze/Unistrut under the cable connected to the cable tray and to (2) 3/8" (or greater) rods to structure above.

        1) Center-hung, single-rod supports are not allowed.

    b. Shelf or L-brackets attached to wood or metal studs.

11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

3.2 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:

    a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.

b. All pathways (e.g., conduit, innerduct, etc.) installed under this work.

1) Label all conduit and innerduct with "TELECOM" or "AV" according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.

a) For wall stub-up locations, label overhead only.
b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.

i) Example – "AV to AV Rack R01".

c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.

i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Confence Room 101A shall be labeled as follows:

(1) Conduit stub-up location in Telecom Room 1A – "Telecom to Conf. Rm 101A Floorbox"
(2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – "Telecom to Telecom Room 1A"

2) All pullboxes and junction boxes for Communications shall be labeled such as "TELECOM PULLBOX", "AV JUNCTION BOX", "TV", etc. on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.

a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie "To AV Box Q:212:01 in Control Rm 212".

c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
d. Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.

a. Assume all floors are fire-rated, unless otherwise noted.

b. Also install fire stops at any other locations indicated in the Specifications or Drawings.

3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:

a. Fire stop Manufacturer
b. Installer and company
c. Date installed
d. UL system number with all relevant ratings indicated

4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2" block letter stencil label on the inside of the telecom room to indicate rating for each barrier.
5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.

C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.

D. Fire-Rated Pathway Device

1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION 270500

SECTION 271000 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Provide a complete functioning telecommunications structured cabling system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Specification sections 271000 through 271999, and Drawings numbered with prefix TN, generally describe these systems, but the scope of the Structured Cabling System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.

C. This section includes additional requirements for the Structured Cabling (Telecommunications) System, which include the following:

1. Quality Assurance requirements, including Contractor qualifications and advanced warranties

1.2 RELATED DOCUMENTS

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

B. Division 27 Section "General Communications".

C. Division 27 Section "Common Work Results for Communications".

D. Requirements of this Section apply to all Sections 271000 through 271999.

1.3 STANDARDS

A. The references to the following standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON):

1. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
2. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
3. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"
4. TIA TSB 140 – "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems"

5. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure
6. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
7. ANSI/BICSI/NECA 568 – "Standard for Installing Commercial Building Telecommunications Cabling"
8. ANSI/BICSI-001 "Information Transport Systems Design Standard for K-12 Educational Institutions"

1.4 GUIDELINES

A. The references to the following guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON)

1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
2. BICSI Telecommunications Distribution Methods Manual (TDMM)

1.5 DEFINITIONS

A. BICSI - Building Industry Consulting Service International

B. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category 3/5e/6/6A copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.

C. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 QUALITY ASSURANCE

A. Personnel Qualifications:

1. Provide and maintain a BICSI Registered RCDD in good standing on staff as a full-time employee at all times. This RCDD shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant.
2. Provide and maintain a Project Manager whom is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend all scheduled project meetings and be responsible for all submittals.
3. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
4. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.
5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.

6. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.

B. Contractor qualifications:

1. Provide a list of projects (no less than 2) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

1.7 ADVANCED STRUCTURED CABLING SYSTEM WARRANTY

A. All components, including but not limited to, connectors, terminal blocks, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of [15] [15] years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and becomes available under warranty for each cable system.

1. Warranty shall be guaranteed by a single reputable manufacturer from below:

a. Belden Incorporated
b. CommScope Inc.
c. Hubbell
d. Legrand/Ortronics
e. Leviton
f. Panduit
g. Siemon
h. Superior Essex Cabling
i. Or Approved Substitution (submitted and accepted in the pre-bid submittal)

B. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

C. Perform the remedial work promptly, upon written notice from the Architect or Owner.

D. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.8 WORK INCLUDED

A. Provide labor, materials, and accessories required to provide complete, operating Telecommunications Infrastructure systems as called for in the Contract Documents and in accordance with applicable codes and regulations. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to the Owner. The work includes, but is not necessarily limited to, the following:

1. All horizontal cabling between the Telecommunications rooms and the outlets.

2. All backbone cabling, including cabling between the Telecommunications Entrance Facility Room and the Telecommunications rooms and designated Telecommunications equipment rooms.
3. All termination blocks, outlets/jacks, patch panels, cabinets, equipment racks, etc., required to support, terminate and/or cross connect cabling at the main cross-connect, Telecommunication rooms and/or other designated equipment locations.
4. All physical cable management hardware including, but not limited to: "J-hooks" in accessible ceiling areas, cable trays, conduits, ladder-type cable racks within telecommunication rooms and "D-rings" on backboards and equipment racks/cabinets/frames.
5. A Grounding/Bonding System, as described in these construction documents.
6. Termination, cross connect and patching of all cable pairs as indicated herein or on schedules or on drawings.
7. Testing, labeling and documentation of all cables and hardware installed under this contract.
8. Preparation and submission of shop drawings, testing reports, as-built drawings, and cabling documentation as described below.

1.9 COORDINATION

A. The locations of cable termination fields, outlets, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.

B. Exercise particular caution with reference to the location of outlets, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.

C. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.

D. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings.

E. Outlet/cable tags in the form of alpha/numeric characters are used where shown to indicate the outlet and cable designation numbers in cable termination fields (terminal blocks and/or patch panels. Show the actual outlet/cable numbers on the as-built drawings, on the associated typed termination field labels and in the printed and computer readable cabling schedules. Where sample outlet/cable-numbering information is not indicated, request clarification from the Architect.

F. The drawings generally do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Provide the correct cable type and quantity as required by the indicated outlets, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI/TIA-568.

G. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

1.10 SUBMITTALS

A. Refer to requirements in Division 27 Section "General Communications Requirements". At a minimum, include the following items:

1. Pre-bid submittal

a. Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
b. Alternate personnel credentials to be reviewed for approval

2. Bid submittal

a. Bid Response Forms
b. Personnel Qualifications / Credentials - Supplemental to Division 1 requirements submit the following documents to indicate the required personnel qualifications per the quality assurance section of this section:

1) Member of staff required to be RCDD

a) A copy of their valid RCDD certificate, RCDD number, and BICSI member number shall be provided with bidding documents.

2) On-site project manager

a) A copy of their valid BICSI Certified Technician certificate and BICSI member number shall be provided with bidding documents.

3) Other personnel physically installing any portion of the Communications infrastructure

a) A copy of their valid BICSI Commercial Installer certificate and BICSI member number shall be provided with bidding documents
b) An alternate certification may be considered by the Design Consultant for approval, which shall be completely at the Design Consultant's discretion.
c) If the contractor chooses to submit an alternate certification from one of the conditionally approved vendor list as an acceptable alternate for a BICSI Commercial Installer, the following shall be included:

i) A valid copy of each certification with the person's name and member number including the manufacturer's logo

ii) A document provided by the manufacturer describing what specific subjects the certification covers, period of time spent doing course work required to gain certification, exam topics, and the requirements needed to maintain the certification.

4) Contractor Qualifications (Previous project references)
5) Voluntary Bid Alternates

3. Pre-construction submittal

a. Warranty information

1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and terms/conditions
2) Proof that Contractor is certified with the Advanced System Warranty manufacturer

b. Resubmit Contractor and Personnel Qualification, update if necessary
c. A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Order shall match that as in these specifications.
d. Manufacturers' cut-sheets, in same order as typed list and in these specifications.

1) At a minimum all cut-sheets shall contain the following:

a) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
b) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo
c) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp, or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
d) For cut-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
e) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

e. Shop Drawings
f. And as required by individual sections in this Division

4. Project completion submittal

a. Preliminary Project Completion submittal requirements:

1) To be submitted:

a) After all horizontal and backbone cabling has been installed, terminated, labeled, tested, and corrected so that all cables and strands pass the Testing Requirements.
b) In conjunction with the Substantial Completion Review request.

i) Design Consultant requires a minimum of 2 weeks notice to schedule the on-site Substantial Completion Review.
ii) Substantial Completion Review shall be a minimum of 1 weeks before Substantial Completion, or earlier if the Project Schedule requires it, to allow for major Punch List items to be address by Contractor.

2) Submittal shall include:

a) Scanned Work Site Prints that include horizontal and backbone cable/outlet labels that correspond to the Test Results.
b) Passing Test Results for all cables and strands, in the following formats:

i) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:

(1) Project Name
(2) Date of Preparation
(3) ID of Work Area Outlet / connector being tested
(4) Date of test
(5) Contractor's Name
(6) Media Type
(7) Make, Model, and Serial Number of test equipment used
(8) Date of last calibration
(9) Names of test crew
(10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
(11) Category or type of cable being tested
(12) Pass or Fail status

ii) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:

(1) Project Name
(2) Date of Preparation
(3) ID of Work Area Outlet / connector being tested
(4) Date of test
(5) Contractor's Name
(6) Media Type
(7) Make, Model, and Serial Number of test equipment used
(8) Date of last calibration
(9) Names of test crew
(10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
(11) Category or type of cable being tested
(12) Full Test Result Data (per Part 3 of this specification)

b. Final Project Completion submittal requirements:

1) Advanced Structured Cabling System Warranty Certificate. Warranty terms and conditions shall contain the following:

a) Length of warranty period
b) Applications covered (future and present)
c) Single manufacturer responsible for fulfilling warranty
d) Who is covered
e) What is covered
f) All disclaimers, limitations, etc.
g) What, if anything, is not covered

2) Product Information

a) Product List (Bill of Materials) – a typed list of products (in order of these specifications), in Excel or CSV file format, indicating:

i) Product Type (as identified in these specifications)
ii) Manufacturer
iii) Model Number
iv) Quantity installed
v) Serial Number (if applicable)
vi) Manufacturer Warranty date (if longer than 1 year)

b) Manufacturer Cut Sheets / Specification Sheets
c) Operation and Maintenance Manuals – manufacturer's installation, service, and maintenance instructions.
d) Warranty certificates (for products not covered by the Advanced System Warranty)

i) If products require registration, register on the Owner's behalf.

3) As Built Drawings

a) At the completion of the project, incorporate changes to the Structured Cabling System noted on the jobsite work prints onto a set of as built Drawings. These changes shall be done electronically and saved to PDF format.
b) Include date and installing contractor's logo and contact information in the title block.
c) Mark each sheet "As Built Drawing".
d) Drawings shall include:

i) Corrected items from Substantial Completion Review punch list.
ii) Cable ID (all characters) for each work area outlet jack (so that they are searchable in the PDF version)
iii) Routing of cable/conduit/cable tray and location of any firestopping systems and pull boxes.

4) Updated, complete Test Results in the following formats (to include the retesting data of any cables installed or modified after Preliminary Project Completion submittal):

a) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:

i) Project Name
ii) Date of Preparation
iii) ID of Work Area Outlet / connector being tested
iv) Date of test

v) Contractor's Name
vi) Media Type
vii) Make, Model, and Serial Number of test equipment used
viii) Date of last calibration
ix) Names of test crew
x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
xi) Category or type of cable being tested
xii) Pass or Fail status

b) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:

i) Project Name
ii) Date of Preparation
iii) ID of Work Area Outlet / connector being tested
iv) Date of test
v) Contractor's Name
vi) Media Type
vii) Make, Model, and Serial Number of test equipment used
viii) Date of last calibration
ix) Names of test crew
x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
xi) Category or type of cable being tested
xii) Full Test Result Data (per Part 3 of this specification)

B. Each structured cabling section (271000-271999) shall be submitted individually. All structured cabling section submittals (271000-271999) shall be submitted on the same date. "Piecemeal" submissions will not be reviewed.

C. For each room or area of the building containing Structured Cabling System infrastructure and equipment, submit the following as part of the shop-drawings and as-built drawings:

1. Floor plans, at not less than 1/8" scale, showing routing of Communications conduits, cable trays, and wireways, including surface-mounted raceways and pullboxes. Also show the routing of bundles of cables supported by "J-hooks", or similar means, if and where such installation practices are allowed by the Contract Documents.

a. Outlet locations shall be identified with jack/module type and label. Coordinate labeling scheme with Owner prior to submitting.

2. Riser diagrams showing types, quantities and schematic routing of all Communications backbone pathways, cabling and the TBB and TBC.
3. Enlarged plan views and elevation layout drawings for the Telecommunications Entrance Facility Room, Telecommunications Rooms and all other designated Telecommunications Equipment Rooms indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than ¼ inch = 1'-0". They shall be prepared in the following manner:

a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).

b. Illustrate all Communications equipment proposed to be contained therein. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
c. Illustrate all other equipment therein such as conduits, detectors, lighting fixtures, ducts, registers, pull boxes, wireways, structural elements, etc.
d. Indicate the operating weight of each piece of equipment.
e. Indicate dimensions to confirm compliance with code-required clearances.
f. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation). (Note: This requirement applies to active Communications equipment such as LAN hubs, routers, amplifiers, radio transmitters/receivers, PBX or key telephone equipment, etc., if installed under this work.)
g. Equipment removal routes for individual equipment items with plan dimensions exceeding 24" by 36" or height exceeding 84".

D. The Communications Equipment room layout submittals and the related Structured Cabling System submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked REVISE AND RESUBMIT.

PART 2 - PRODUCTS

2.1 110-STYLE PUNCHDOWN TOOL

A. Manufacturer shall be Panduit PDT-110 or equivalent.

2.2 COPPER TESTING EQUIPMENT

A. Category 3/5e Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Category 3/5e UTP cable Tester

1) Fluke
2) Ideal
3) Softing
4) Viavi

2. Requirements

a. The field tester shall be a level II-E (IIe) or greater.
b. The field tester shall meet the requirements of ANSI/TIA-568.

B. Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Category 6 Cable Tester

1) Fluke

2) Ideal
3) Softing
4) Viavi

2. Requirements

a. The field tester shall be a level III or greater.
b. The field tester shall meet the requirements of ANSI/TIA-568.

C. Augmented Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Augmented Category 6 Cable Tester

1) Fluke
2) Ideal
3) Softing
4) Viavi

2. Requirements

a. The field tester shall be a level III-E (IIIe) or greater.
b. The field tester shall meet the requirements of ANSI/TIA-568.

2.3 OPTICAL FIBER TESTING EQUIPMENT

A. OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Optical Time Domain Reflectometer (OTDR)

1) Fluke
2) Ideal
3) Softing
4) Viavi

2. Requirements

a. An OTDR shall be used to provide Tier Two testing, which shall provide information regarding attenuation, connector location and insertion loss, splice location and splice loss, and any other power loss events that may have been created during installation.
b. The OTDR shall be utilized from both ends of the fiber strand to better isolate any potential problems.
c. For unterminated fiber, a "bare fiber adapter" shall be utilized.

B. OPTICAL POWER MEASUREMENT METER

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Optical Power Measurement Meter

1) Fluke
2) Ideal
3) Softing
4) Viavi

2. Requirements

a. An Optical Loss Test Set (OLTS) shall be used to provide Tier One testing, which shall provide information regarding link attenuation, continuity, and polarity of the installed fiber optic cable.
b. The OLTS shall be used with the appropriate adapters to allow connectivity to the optical fiber link.
c. The OLTS shall meet the launch requirements of ANSI/TIA-455-78B.

C. OPTICAL FIBER INSPECTION SCOPE (or FIBER VIEWERS)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a. Optical Fiber Inspection Scope

1) AFL
2) EXFO
3) Fluke
4) Softing
5) Viavi

2. Requirements

a. An Optical Fiber Inspection Scope shall be utilized to examine all ends of fiber optic strands prior to splicing or termination.
b. The Optical Fiber Inspection Scope shall have a minimum of 400x magnification. If the cable and/or connectivity manufacturer requires greater magnification to meet their installation requirements, the more restrictive standard shall apply.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 IDENTIFICATION / LABELING

A. General

1. Labels or tags containing a unique cable ID designator as specified on the drawings or herein shall be placed on both ends of all cables, 6 inches (152.4 mm) from the connector and/or terminal block.
2. Label or tag all cables passing through Telecommunications rooms.
3. Subsequent to placing and terminating cables, place the appropriate cable label.

4. The administration of the Telecommunications infrastructure includes:

    a. Labels (plates, tags, etc.) to identify individual components.
    b. Schedules (or other records (printed and/or in computer data base form) to document information about the individual components and the relationships between them.
    c. Plans or drawings to assist with visualizing the physical and/or logical locations of the components.

5. Provide labels on all applicable items installed under this work and to provide all related records and drawings so that the Owner will be able to administer the Telecommunications infrastructure.

B. Labeling Installation

1. Labels that are to be secured by adhesive shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.
2. Labels, plates and tags are to be installed in such a manner that they will be accessible, both physically and visually, after completion of the work. (Exception: It is understood that labels on the outlet end of station cables are generally not visible unless the face plates, bezel, module, etc., is removed or opened.)
3. Any temporary labels used during installation, cable pulling, etc. are to be removed and replaced by the permanent labels identified in Part 2 of this specification before the work will be accepted.
4. If at any time during the job the cable tag becomes illegible or removed for whatever reason during the construction period, immediately replace it with a duplicate pre-printed cable tag at the Contractor's expense before the work will be accepted.

C. Labeling Requirements

1. Labels, plates and tags are to be installed on:

    a. All Telecommunications rooms (spaces).
    b. All horizontal links and their components, including:

        1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all horizontal cables installed under this work.
        2) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
        3) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work.
        4) Labeling the Telecommunications outlet housing individual connectors in the work area.

            a) Labeling each connector terminating horizontal cables in these outlets.
            b) Label identification within a given space (work area) shall begin at the entrance to the space and proceed in a clockwise manner around the space.

        5) Any additional components required by ANSI/TIA-606

    c. All components of the commercial grounding and bonding system for Telecommunications; to include but not limited to all bonding conductors, PBB and SBB's.

d. All building backbone cables and their components, including:

1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
5) Any additional components required by ANSI/TIA-606.

e. All required fire stopping systems.
f. All campus backbone cables and their components, including:

1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
5) Any additional components required by ANSI/TIA-606.

g. All pathways (e.g., inner duct, cable racking, conduit, etc.) installed under this work.

1) All interior pathways including cable trays and conduits shall be striped, traced, colored, or marked.

h. Provision of a database that records appropriate information regarding all cabling, terminations, frames, racks, etc. installed under this work.
i. In general, the label, plate or tag is to be provided and installed by whoever installed the item that is being labeled.
j. Refer to individual Telecommunications specification sections (Division 27) and to the Telecommunications drawings for additional information on labeling requirements.

3.3 TEST REPORTS FOR THE STRUCTURED CABLING SYSTEM

A. General cable testing

1. Pre-installation testing:

a. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
b. Where post-manufacturer test data has been provided by the manufacturer on the reel, box or shipping carton: submit copies to the Owner prior to installing cables.
c. Mark reels or boxes as tested/inspected and submit associated test results to Owner/Design Consultant.
d. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

2. Post-installation testing:

    a. Calibrate all testers prior to use in accordance with manufacturers' printed instructions.
    b. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.
    c. Remove all defective cables from pathway systems. Do not abandon cables in place.

3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.

    a. Prior to testing, submit for review and approval copies of test report forms proposed for use.
    b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.

B. Copper cable testing

1. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.
2. Paired and multi-conductor riser metallic cables:

    a. After terminating and splicing the cables. Test all cable pairs for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
    b. After installing cross-connects, perform end-to-end testing of each cross-connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
    c. Cable test reports: As a minimum, also provide: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.

3. Four-Pair Cables:

    a. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:
        1) Category 6 UTP

            a) Wire map
            b) Length
            c) Insertion loss
            d) Near-end crosstalk (NEXT) loss.
            e) Power sum near-end crosstalk (PSNEXT)
            f) Equal-level far-end crosstalk (ELFEXT)
            g) Power sum equal-level far-end crosstalk (PSELFEXT)
            h) Return loss
            i) Propagation delay
            j) Delay skew

        2) Augmented Category 6 F/UTP Cables

            a) Wire map
            b) Length

c) Insertion loss
d) Near-end crosstalk (NEXT) loss.
e) Power sum near-end crosstalk (PSNEXT)
f) Equal-level far-end crosstalk (ELFEXT)
g) Power sum equal-level far-end crosstalk (PSELFEXT)
h) Return loss
i) Propagation delay
j) Delay skew
k) Alien Crosstalk (AXTalk) – Follow manufacturer's instructions for method

4. After installing cross-connects, perform end-to-end testing of each cross-connected cable for continuity, ground fault, proper cross-connection, shorts and crossed pairs. For 100 pair or smaller cables, replace entire cable if bad pair is found. For larger pair-count cables, replace if more than 1% of pairs are bad.
5. Submit the following information regarding the cable testing: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair (if applicable), results of each test for each pair and total number of serviceable pairs in cable.
6. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and copper test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

C. Optical Fiber cable testing

1. Post-installation testing:

a. After installation of connectors, visually inspect each fiber end-face at 50X magnification. Refinish fibers with visible defects and/or striations in the core area.
b. Perform end-to-end, bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm. Conduct tests in accordance with TIA-526-14, Method B and with test instrument manufacturer's printed instructions.
c. Perform end-to-end, bi-directional attenuation (loss) test for each singlemode fiber strand at 1310 and 1550 wavelengths. Conduct tests in accordance with TIA-526-7, Method A.1 and with test instrument manufacturer's printed instructions.
d. Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is defined as the sum of: the connector losses (based on the number of mated connector pairs at the ANSI/TIA-568 maximum allowable loss of 0.75dB per mated pair) and the optical fiber loss (based on length and the ANSI/TIA-568 maximum allowable loss (3.5dB/km @ 850nm and 1.5dB/km @1300nm for multi-mode and 1.0dB/km @1300 and 1550nm for single-mode) by more than 1.0dB.
e. Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, at OTDR shall be used to: determine the true loss for each connector pair, the exact length of the fiber and to identify the presence of any core damage.
f. Faults related to fiber being connectorized shall be corrected, and the fiber re-tested as described above, until acceptable attenuation measurements are recorded.
g. Where defects are found to be inherent in the fiber itself: replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.
h. Provide testing in accordance with manufacturer's requirements for a fully-warrantied cabling system(s) as required by these Contract Documents.

2. Testing jumpers used shall remain connected at the test equipment for the entire duration of testing. If at any time the jumper becomes loose or removed, for any reason, the jumper

shall be reinstalled and re-referenced. This procedure shall be documented each time it is performed to indicate date, time and who performed the procedure. This log shall accompany test reports submitted.

3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.

    a. Prior to testing, submit for review and approval copies of test report forms proposed for use.
    b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.
    c. Cable number, fiber count, individual fiber numbers, connector types, number of connectors/patches, calculated maximum link loss, length or run, measured link loss for each fiber.

4. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and fiber test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

D. Acceptance

1. The Owner and Design Consultant reserve the right to observe the conduct of any or all portions of the testing process.

    a. The Owner and Design Consultant further reserves the right to request the Contractor conduct a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results during the Substantial Completion Review. If more than 5% of these randomly tested cables do not pass, the Owner and Design Consultant reserves the right to require a re-testing of 100% of the cable plant, all without additional costs to the project.

2. For 100 pair or smaller replace entire cable if a bad pair or conductor is found. For larger pair count cables, replace if more than 1% of pairs are bad.
3. All test results are to be documented and submitted to the Architect in a timely manner, in accordance with the Submittal instructions in Part 1 of this section.

    a. Corrective procedures following the Substantial Completion Review shall be properly documented, and affected and new cables shall be retested prior to Substantial Completion.
    b. Updated complete Test Results, including retested, new and unaffected cables, shall be included in the Final Project Completion submittal.

3.4 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. The complete build-out of all Communications Rooms, cleaned of dust and debris.
2. Installation, termination, final labeling, and testing of all backbone and horizontal cabling.
3. The installation and labeling of all firestopping systems required for Telecommunications cabling and outlets. If firestopping was provided by a separate contractor (per Division 27

"Common Work Results for Communications"), ensure all firestopping systems are installed and labeled.

4. The installation, labeling, and testing of the Telecommunications Grounding and Bonding System.
5. Ensure faceplates are level, free of dust and paint, match color/style of adjacent electrical receptacle, and have blue protective film removed.
6. Update jobsite Work Prints with all individual port / cable IDs, which shall correspond to the cable IDs in the Test Results.

    a. These shall then be scanned to PDF (minimum resolution of 150 dpi) to be included in the Preliminary Project Completion documentation outlined in the Part 1 Submittal requirements earlier in this section.

B. Request in writing a review for Substantial Completion. Refer to Part 1 Submittal requirements earlier in this section for required notice and Preliminary Project Completion documentation that shall be included with this request.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion for the (Telecommunications) Structured Cabling System.

D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

3.5 SPECIAL TOOLS

A. Delivery to Owner's representative 2 complete sets (UON) of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.

B. The terms "special tools" and "small equipment items" is meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars ($500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.

END OF SECTION

SECTION 271100 - TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:

1. Bonding and Grounding (Earthing)
2. Plywood Backboard
3. Cabinets, Racks, Frames, and Enclosures
4. Termination Blocks and Patch Panels
5. Cable Management and Ladder Rack

B. Section does not specify fittings such as cables, cable terminations, termination blocks, and patch panels for structured cable system (SCS). These components are specified in the Division 27 Section "Communications Backbone Cabling" and Division 27 Section "Communications Horizontal Cabling".

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".

B. Division 27 Section "Seismic Controls for Communications"

C. Division 26 Section "Grounding and Bonding for Electrical Systems".

1.3 DEFINITIONS

A. Backbone Bonding Conductor (BBC) – The conductor that interconnects elements of the telecommunications grounding infrastructure.

B. Communications Equipment Room – This term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

C. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 "Optical Fiber Cables and Raceways" and Article 800 "Communications Circuits" of NFPA 70 "National Electrical Code".

D. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19" or 23" inches.

E. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19" or 23" inches.

F. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.

G. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19" or 23" inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).

H. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

I. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

J. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

K. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).

L. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

1.4 SUBMITTALS

Follow the requirements for submittals in Division 27 Sections "General Communications Requirements" and "Structured Cabling System". QUALITY ASSURANCE

A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.

B. Communications equipment room fittings shall be listed by a NRTL.

PART 2 - PARTS AND MATERIALS

2.1 BONDING AND GROUNDING (EARTHING)

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard "Generic Telecommunications Bonding and Grounding for Customer Premises". Major components include:

a. PBB in the Entrance Facility and SBBs in all remaining Telecommunication Rooms and Spaces.
b. TBC connecting the PBB to the main Electrical Service Ground.
c. TBB connecting the PBB to all SBBs.
d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.

2. Available Component Manufacturers:

a. Chatsworth
b. Cooper B-Line
c. Erico
d. Harger
e. Hoffman
f. Panduit

3. Conductor Manufacturers

a. Shall be from the list of Component Manufacturers; or
b. Shall be from the list of Manufacturers in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Primary Bonding Busbar (PBB)

1. Specifications

a. All busbars shall have a clear cover installed to protect connections
b. Cover shall be:

1) Plexiglass or plastic
2) Cover shall be printed with 3/8" lettering "PBB" using appropriate labels.
3) Of the same manufacturer as the ground bar

c. A predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
e. Provide enough length for all connections with 25% growth.
f. Provided with insulators to electrically isolate busbar from mounting surface.
g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

a. Harger TGBIP14420TMGB
b. Chatsworth 40153-020
c. Or equivalent from Component Manufacturer

C. Secondary Bonding Busbar (SBB)

1. Specifications

a. Be a predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs
b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long

c. Provided with insulators to electrically isolate busbar from mounting surface
d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

a. Harger TGBI14212TGB
b. Chatsworth # 13622-012
c. Or equivalent from Component Manufacturer

D. Ground Wire for TBB

1. Specifications

a. All grounding and bonding connectors shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as required by the NEC.
b. All grounding and bonding conductors shall be copper and may be insulated UON. When conductors are insulated, they shall be listed for the application (i.e. Plenum, riser, outside plant, etc.)
c. Ground Wire for TBB: Non-Insulated grounding wire with a minimum conductor size as indicated on drawings. Wire shall be UL listed.
d. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name.
2) Copper Conductor Gauge.
3) UL listing.

e. Cable jacket shall be green with black lettering.
f. Sizing shall be per Part 3 of this section. All sections of TBB longer than 300 feet shall be 750 kcmil.

E. Bonding Conductor (To main Electrical service ground) for Telecommunications (TBC): Insulated grounding wire with a minimum copper conductor size equal to that of the TBB, with PVC insulation. Shall be UL listed.

1. Specifications

a. Shall be copper.
b. Insulated grounding wire with PVC insulation
c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the PBB, UON.
d. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name
2) Copper Conductor Gauge
3) NRTL listing information

e. Cable jacket shall be green with black lettering
f. A minimum conductor size as indicated on drawings

F. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)

1. Specifications

a. Shall be copper.

b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
d. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name.
2) Copper Conductor Gauge.
3) UL listing.

e. Cable jacket shall be green with black lettering.

G. Connectors / Connections

1. Specifications

a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.
b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.

2. Compression Lugs

a. Specifications

1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
2) Shall include inspection port.
3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

b. Manufacturer shall be:

1) Harger GECLB Series
2) Or Approved Equivalent

3. Conductor to conductor connection

a. Specifications

1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.

b. Manufacturer – Exothermic Weld

1) Erico CADWELD
2) Harger Ultraweld
3) Or Approved Equivalent

c. Manufacturer – Irreversible Compression connector

1) Burndy HYGROUND
2) Or Approved Equivalent

4. Connector for conduit to cable

    a. Specifications

        1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the PBB/SBB.

    b. Manufacturer shall be:

        1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe lamp
        2) For less than 1" diameter conduits – Harger TBGC4SCS elctro tin-plated conduit bonding clamps
        3) Or Approved Equivalent

5. Connector for conductor to cable tray

    a. Specifications

        1) For metallic cable trays that extend to the Telecommunications Room.

    b. Manufacturer shall be:

        1) Harger electro tin-plated cable tray bonding clamps – TBCTC
        2) Or Approved Equivalent

H. Insulated Grounding Bushings

1. Specifications

    a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
    b. Shall be UL Listed for copper conductors.
    c. Shall include lug for easy connection of conductor to PBB/SBB.

2. Manufacturer shall be:

    a. O-Z/Gedney IBC-L
    b. Or Approved Equivalent

2.2 PLYWOOD BACKBOARD

A. 4' x 8' sheets of 3/4" thick (minimum) fire-retardant plywood shall be painted white with fire-retardant paint.

2.3 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

A. Two-Post Floor Rack

1. The following manufacturers are Conditionally Approved:

    a. APC

b. B-Line
c. Chatsworth Products
d. Great Lakes
e. Hoffman
f. Middle Atlantic
g. Ortronics
h. Panduit
i. Or connectivity manufacturer carrying structured cabling warranty
j. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Requirements

a. Approximately 7'-0" in height with 45U available to mount panels/equipment.
b. Mounting rails shall be spaced 19" wide per ECA EIA/ECA-310-E. Mounting rails shall contain #12-24 tapped holes for patch panel applications. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
c. Two-post rack shall be minimum 14 gauge carbon steel construction and have a self-supporting base.
d. Finish shall be powder coat inblack. Provide touch-up paint matching powder coat.
e. Minimum static load capacity: 1,000 lb
f. UL Listed
g. Secure rack to floor. Provide rack manufacturer's rack installation kit matching floor type of rack installation for a complete system meeting drawings and manufacturer instructions. Raised floor racks shall be mounted to sub or base floor with 5/8" threaded rods and steel brackets.
h. Provide 6" stand-off bracket accessory on top of rack to mount ladder rack.
i. Provide free standing relay rack accessories: rack base insulator kit, rack line-up spacer kit, rack base dust cover, equipment support bracket, equipment guard rail, and RMU Label Kit for a complete system meeting drawings and manufacturer instructions.

2.4 TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

A. General

1. All telecommunications termination blocks and patch panels shall be by the same manufacturer and covered under the same Advanced Structured Cabling System Warranty.
   a. Refer to Advanced System Warranty sub-section of Division 27 "Structured Cabling System" for list of approved connectivity manufacturers.

B. Rack-mount Modular - Copper Patch Panels

1. General Requirements for Patch Panels: Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
2. Patch panels shall be provided complete with all mounting hardware, jacks, retainers, wire guides, designation strips, etc.
3. Patch panels shall accept modular jacks of exactly one port, and this modular jack shall be the same type as being installed at the far-end faceplates.
4. Provide enough ports for the number of cables terminated on the patch panel, plus 25 percent spare. Provide all connector blocks', including plugs and jacks where required to fill each panel completely. Do not leave any blank openings.
5. Modular Patch Panels shall be of a metal design with snap in module frames for each individual jack.

6. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard EIA 19" racks.
7. Horizontal Cabling

    a. Four-pair Augmented Category 6 Category 6 UTP cabling shall be terminated onto a four-pair Augmented Category 6 Category 6] jack module. All jack modules shall be terminated using the T568B wiring scheme. The eight-position jack module shall exceed the connector requirements of the TIA Augmented Category 6 Category 6 standard.

C. Rack-mount Optical Fiber Panels

1. Fully enclosed cable management type patch panel. Rack mountable in equipment cabinets/racks. Front and rear access (front access only for wall mounted). Complete with all necessary cable clamps, couplings and connector bulkheads.

    a. Optical fiber cables shall be terminated in cable management trays/modules.
    b. Cable management module/tray can accommodate optical fiber patch cable. Tray/module shall provide a means to avoid exceeding the cable manufacturer's minimum bending radius to protect against crimping or over bending.
    c. Cable management tray shall have labeling on the front of the tray.
    d. Optical fiber patch panels shall have a plexiglass latching front panel. Labeling and connectors shall be clearly visible with front panel open or closed.
    e. Optical fiber patch panels shall accept a variety of inter-changeable bulkheads including ST, SC, LC, FDDI as well as attenuators.
    f. Optical fiber patch panels shall provide a splice tray option.

2. Optical fiber termination method(s)

    a. Factory-terminated pigtail and with fusion splice
    b. Multi-mode connectors:

        1) Duplex multimode LC connectors and adapters. Color shall be beige. Suitable for use with specified multi-mode optical fiber. Maximum insertion loss across mated pair: less than 0.75dB.
3. Submit Manufacturer and part number as part of pre-construction submittals.

2.5 TELECOMMUNICATIONS PATCH CABLES & CROSS-CONNECT WIRES

A. General

1. Supply all necessary patch cables and cross-connect wires as part of a complete and functioning telecommunications system to support voice, data, audio-video, security, and other miscellaneous systems.
2. The manufacturer of patch cables shall be the same as the telecommunications connectivity, unless otherwise specified.
3. All patch cables shall be factory-terminated and tested.

B. Fiber Optic Patch Cords

1. Multimode

    a. Multimode type shall match that of fiber backbone cabling/adapters (OM3) and terminations

b. Connectors shall be LC on both ends
c. Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:

1) Total quantity shall be100% of the terminated ports, in the following lengths:

a) All shall be 7'

d. Manufacturer shall be:

1) Same as fiber connectivity manufacturer
2) Submit product cutsheet for review

2.6 TELECOMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

A. Ladder Rack (Cable Runway)

1. Color: black
2. Rung Spacing: 9"
3. Width: 18"
4. UL Listed as an equipment grounding conductor
5. Provide ladder rack components such as e-bend, outside radius bend, and corner bracket for a complete system meeting drawings and manufacturer instructions.
6. Provide ladder rack supports such as wall angle support kit, triangular support bracket, center support kit, threaded rod, I-beam clamp, threaded ceiling kit, cabinet elevation kit, foot kit, rack mounting plate, rack elevation kit for a complete system meeting drawings and manufacturer instructions.
7. Provide ladder rack accessories such as cross member radius drop, end caps, and dividers for a complete system meeting drawings and manufacturer instructions.
8. The following manufacturers are Conditionally Approved:

a. B-Line
b. Chatsworth Products
c. nVent/Hoffman
d. Middle Atlantic
e. Or connectivity manufacturer carrying structured cabling warranty
f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

B. Vertical Cable Managers

1. Manufacturer shall be the same as equipment racks and cabinets, unless otherwise noted.
2. Color: black
3. Size: as specified on drawings, or a minimum of 6" wide by 6" deep, whichever is greater.
4. The following manufacturers are Conditionally Approved:

a. B-Line
b. Chatsworth Products
c. Ortronics
d. Panduit
e. Or connectivity manufacturer carrying structured cabling warranty
f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

C. Horizontal Cable Management

1. Manufacturer shall be the same as copper connectivity manufacturer.
2. Color: black
3. Size: 1RU or 2RU
4. The following manufacturers are Conditionally Approved:

    a. Belden
    b. Hubbell
    c. Leviton
    d. Ortronics
    e. Panduit
    f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 GROUNDING AND BONDING INSTALLATION

A. General:

1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. "Daisy chaining" of Telecommunications ground bus bars back to the PBB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a "coupled bonding conductor" effect
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Telecommunications Bonding Conductor (TBC), each Telecommunications bonding backbone (TBB) conductor, and each Backbone bonding conductor (BBC shall be green or marked with a distinctive green color

    a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods
    b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.

6. Follow additional installation requirements from NECA/BICSI 607-2011 "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings".

B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the SBB in the room. Each conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
2. Provide and install one individual ground wire from the raised floor system (if applicable) to the PBB. Conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the SBB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specified labeling requirements for each conductor.

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER

E. Quantities of Ground Wires (Conductors)

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.
2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

1. Subject to the applicable electrical code and the reference standards and guidelines, the TBC, TBB, BBC conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size

less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):

    a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

3.3 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES INSTALLATION

A. Wall cabinets, racks, frames, and enclosures shall be installed on a plywood backboard or attached to a masonry wall. The rack should not be attached to sheet rock (gypsum wall board).

B. Tags/labels shall be placed on each equipment rack, cabinet and frame in accordance with specification Division 27 Section ""Common Work Results for Communications"

3.4 CABLE LADDER RACKING

A. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568C & 569, NFPA 70 (National Electrical Code), NEMA VE2, and applicable local codes.

B. Install cable ladder racking level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

C. Install cable ladder racking where indicated in the drawings and as required by these Specifications

D. Corner clamp brackets shall be used to join sections of cable ladder rack that are perpendicular to each other.

E. Cable ladder rack stringers shall be attached to plywood backboards with angle brackets and "J" bolts.

F. End supports and stringer junction brackets shall be used to attach vertical cable ladder segments to the floor.

G. Stringer junction brackets shall be used to attach end to end horizontal cable ladder rack segments.

H. Open ended stringer segments shall be closed with corner clamps and end bars.

I. Mounting plates and "J" bolts shall be used to attach the cable ladder racking to the relay racks or equipment cabinets.

J. Runway should be supported every[5 feet on center with1/2 inch diameter threaded rod with slotted hanger clamps, or applicable support brackets or attachments. All wall brackets shall be attached to plywood backboard.

K. A support shall also be placed within 24 in. on each side of any connection to a fitting.

3.5 CABLE MANAGEMENT AT EQUIPMENT RACKS AND CABINETS

A. Install cable organizers and/or cable channel on equipment racks and within cabinets at locations as described in the Specifications and/or indicated on the Drawings.

3.6 QUANTITIES OF RACK/CABINET AND DISTRIBUTION FRAME EQUIPMENT AND COMPONENTS

A. Location and placement of communications equipment room fittings shall be as shown on the Drawings or defined in these specifications and schedules.

B. Quantities and sizes of communications equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.

C. Equipment racks, cabinets and distribution frames shall be assembled and installed as per the manufacturers' printed instructions.

END OF SECTION

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Provide a complete intra-building (premises) backbone cabling system in accordance with these Contract Documents. Including but not limited to, the following:
   1. Optical Fiber Cables
   2. Splices (where required by these Contract Documents)
   3. Necessary installation and supporting hardware.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"

B. Division 27 "Common Work Results for Communications"

C. Division 27 "Structured Cabling System"

D. Division 27 "Telecommunications Equipment Room Fittings"

1.3 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications 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.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568, when tested according to test procedures of this standard.

1.5 CODES, REFERENCES, AND STANDARDS

A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".

1.6 GUIDELINES

A. Follow all applicable guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".

1.7 QUALITY ASSURANCE

A. Refer to Division 27 Section "Structured Cabling System" for Quality Assurance requirements.

1.8 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements", as well as the detailed Submittal requirements in Section "Structured Cabling System". The following additional items shall be submitted:

B. Pre-Bid Phase:

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. "Pre-construction" submittal:

1. Shop Drawings:

a. Submit for review scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and proposed cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.

2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
3. Submit manufacturers' cut sheets or catalog cut sheets for:

a. Each of the cables specified:

1) Cut sheets shall include the following information at a minimum:

a) Manufacturers name and logo
b) Cable outside diameter
c) Number of conductors/strands in each cable and binder group
d) Gauge or strand thickness
e) Minimum transmission performance rating
f) Cable jacket material and rating
g) Maximum pulling tension
h) Jacket/Sheath color
i) Individual conductor or strand insulation colors
j) Minimum bend radius

i) During installation and post installation.
ii) As well as any additional information required by individual sections of this Division.

D. "Project Completion" submittal:

1. As-built Drawings:

a. Submit scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and final cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

1.9 WARRANTIES

A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PRODUCTS AND MATERIALS

2.1 MULTI-MODE OPTICAL FIBER CABLE

A. General

1. Requirements

a. See Division 27 and backbone (riser) diagram(s) on the Drawings for required fiber counts.
b. Cable shall meet the transformation performance and physical specifications of ANSI/TIA-568.
c. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name and trade mark
2) Fiber size
3) Fiber Grade
4) UL listing (Shall be suitable for the application)
5) Sequential length markings

d. Type: OM3
e. Cable jacket color shall be:
1) AQUA for laser optimized multi-mode fiber optic cable

f. Fiber Size – 50/125 µm
g. Maximum allowable attenuation (db/km) is 3.5 at 850nm and 1.5 at 1300nm.

B. Intra-building; cables that remain within the envelope/footprint of the building that are not installed within pathways defined to be in "wet" locations

1. Requirements

a. Cable shall have an overall armor of steel or aluminum.

b. Cable jacket shall beplenum (OFNP | OFCP) rated.

C. Intra-building; cables that remain within the envelope/footprint of the building that are installed within pathways defined to be in "wet" locations

1. Requirements

a. Cable shall have an overall armor of steel or aluminum
b. Cable jacket shall be indoor/outdoor plenum cable and suitable for installation such environments.
c. Cable jacket rating shall be consistent with manufacturer's requirements to be covered under warranty specified.

2.2 SPLICES (SPLICE CASES)

A. In general, optical fiber cables are not to be spliced except where indicated otherwise in the Drawings and Specifications.

1. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for splicing requirements integral to rack-mounted enclosures.

B. Where splicing is indicated in the Drawings and Specifications, multi-mode and single-mode optical fiber cable splicing shall be fusion spliced. Provide splice case with trays to accommodate all fiber strands that enter case.

C. Multi-mode and single-mode optical fiber cables shall be spliced at points indicated on the Drawings.

1. End caps with hole configurations to meet cable sheath diameters without filters.
2. Plugs for all unused end cap holes.
3. Trays shall be used to hold all splices.
4. Optical fiber cables shall be labeled between 6" and 12" from their entry to the splice case.

D. Maximum allowable loss for splices is 0.3 db.

E. Manufacturer shall be:

1. Preformed Line Products – Coyote Fiber Optic Closures series
2. Or approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 CABLE INSTALLATION

A. General:

1. Place all backbone cabling in accordance with these specifications, on the Drawings and as indicated on any cable schedules.
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.

    a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
    b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.

3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/cable ladder system. Refer to the Telecommunications floor plan and detail drawings for the layout of the conduits, cable tray and cable ladder.

    a. Backbone cables in which no portion of the cable jacket will be exposed when routed in a plenum or other air handling space, shall be riser rated (CMR, MPR, OFNR, or OFCR). Cables suitable for use in air plenums or other air handling spaces, and which meet the electrical/transmission specifications, are also acceptable for riser applications.
    b. Backbone cables in which any portion of the cable jacket will be exposed when routed in an air plenum or other air handling space shall beplenum (CMP, MPP, OFNP, or OFCP) rated.
    c. Backbone cables installed in "wet" locations as defined by the NEC or in these construction documents shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
    d. Backbone cables routed vertically within a Telecommunications Room shall be supported by velcro-attachment every 18" to vertically-mounted ladder rack or D-rings.

4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

    a. Except when supported by ladder racking or D-rings within each Telecommunications room, UON.

5. All backbone cables running on ladder racking within all Telecommunications rooms throughout the building shall be neatly placed and secured to the horizontal and vertical ladder racking with cable lacing twine or nylon wire ties at intervals not to exceed every third rung plus all locations where the cable changes direction.
6. At the same time backbone cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
7. Do not install 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. Where distance allows all backbone cables shall be provided with slack/service loops at each end of the cable. Each slack/service loop shall be:

    a. A minimum of (10) feet in length, UNO
    b. Configured in a loosely formed figure eight configuration (ie. not coiled)

9. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
10. Comply with all referenced standards and guidelines
11. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
12. Where backbone cabling has a shield or metallic member, the shield or metallic member shall be bonded to the TMGB/TGB in accordance with ANSI/TIA-607 and BICSI/NECA 607-2011.

B. Outside plant cable installation: for cables placed in "wet locations". These locations include but are not limited to; pathways that extend outside the envelope of the building such as aerial entrances, direct buried cables, underground conduits, conduits embedded in, or routed below a ground floor slab, etc.

1. Unlisted cables shall transition to an indoor rated cable within 50' of the entrance point as required the NEC.

    a. This 50' allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)

2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling spaces nor shall they be allowed to transition between different levels of the building.
3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.

    a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.

4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50' of the transition point to indoor rated cabling in accordance with the NEC.
5. Cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings".

3.3 OPTICAL FIBER CABLE INSTALLATION

A. General:

1. Place all optical fiber backbone cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
2. Splices between optical fiber cables are permitted only at those locations indicated on the Drawings.
3. Splices between riser rated optical fiber cables and factory connectorized pigtails are permitted, but not required at each fiber termination location indicated on the Drawings. Pre-terminated riser cables meeting the material specifications may be utilized.
4. Comply with all referenced standards and guidelines.

B. Pre-installation testing:

1. Optical fiber cables: Perform visible light continuity check on each fiber. If one end is not accessible: perform OTDR test to assure fiber continuity.

C. Optical Fiber Backbone Cables:

1. Place between the optical fiber Main Distribution Frame (MDF) and the Telecommunications rooms as noted in the cable schedules and the Drawings.
2. Optical fiber cable is to be installed within inner duct at all locations where it is within nominal 4-inch conduit (not including short conduit sleeves.)
3. Support optical fiber riser cables with suitable support grips. After being supported, the optical fiber cables will be routed over to the optical fiber patch panel in that particular Telecommunications room.

3.4 OPTICAL FIBER MAIN DISTRIBUTION FRAME

A. Optical fiber cables shall be routed to the Fiber MDF from each of the Telecommunications Rooms via conduits, trays and riser sleeves. See the Drawings.

B. Optical fiber cables shall enter the Fiber Distribution Frame from the top of the frame and then routed to the connector and splice modules/shelves.

3.5 CABLE IDENTIFICATION

A. Label all backbone cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.

B. Cables shall be labeled within 6" at each end and within each pullbox.

C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

1. Brady, IDXPERT
2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or equivalent

3.6 CABLE TERMINATIONS

A. Terminate all backbone cabling specified in accordance with Division 27 Section "Communications Equipment Room Fittings", No cables shall contain unterminated elements UON.

3.7 CABLE TESTING

A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.8 ACCEPTANCE

A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.

B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or strand is found.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Provide a complete Category 6 and 6A horizontal (work area) telecommunications cabling system as shown on the TN sheets and in accordance with these Contract Documents.

B. This section specifies the following:

1. Horizontal Copper Cable
2. Copper Connectivity
    a. Faceplates
    b. Surface Box
    c. Jacks/plugs/inserts

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"

B. Refer to Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.

C. Refer to Division 27 Section "Structured Cabling System" for Advanced System Warranty information and other requirements.

D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for telecommunications equipment racks, patch panels, wall-blocks, surge suppressors, and other equipment room requirements.

1.3 CODES, STANDARDS, AND GUIDELINES

A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System", follow the most recent editions of the following:

1. NFPA 70 (NEC) – "National Electrical Code" (NEC)
2. IEEE NESC - "National Electrical Safety Code"
3. ANSI/BICSI 005 – "Electronic Safety and Security System Design and Implementation Best Practices"
4. ANSI/NECA/BICSI-607 – "Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings"
5. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
6. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"

7. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
8. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
9. BICSI – "Telecommunications Distribution Methods Manual"
10. BICSI – "Information Technology Systems Installation Methods Manual"
11. IEEE 142 – "Recommended Practice for Grounding of Industrial and Commercial Power Systems" (Green Book)
12. IEEE 1100 – "Recommended Practice for Powering and Grounding Electronic Equipment" (Emerald Book)
1. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"
13. TIA-TSB-140 – "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems"

1.4 DEFINITIONS

A. Advanced System Warranty – refer to Division 27 Section "Structured Cabling System".

B. Communications Equipment Room - This CSI MasterFormat term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

C. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.

D. Horizontal Cabling

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

    a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
    b. Bridged taps and splices shall not be installed in the horizontal cabling
    c. Splitters shall not be installed as part of the optical fiber cabling

2. A work area is approximately 100 sqft (9.3 sqm), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
3. The maximum allowable horizontal cable length for Category copper cable is 295 feet (90 meter). This maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) in the horizontal cross-connect.
4. Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.

E. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed copper Category and fiber optic cable terminated onto a patch panel or outlet.

1.5 QUALITY ASSURANCE

A. As a minimum, the person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.

B. All testing equipment used shall have the latest version of software and/or firmware installed prior to testing any cabling. Testing equipment shall also undergo all manufacturers' required and recommended routine maintenance.

1.6 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements"

B. Pre-bid submittal

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. Pre-construction submittal

1. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters)
2. Submit manufacturers' cut sheets or catalog cut sheets for:

a. Each of the cables specified. Cut sheets shall include the following information at a minimum:

1) Manufacturers name and logo
2) Cable outside diameter
3) Number of conductors/strands in each cable and binder group
4) Gauge or strand thickness
5) Minimum transmission performance rating
6) Cable jacket material and rating
7) Maximum pulling tension
8) Jacket/Sheath color
9) Individual conductor or strand insulation colors
10) Minimum bend radius

a) During installation and post installation.
b) As well as any additional information required by individual sections of this Division.

b. Faceplates and modules. Cut sheets shall include the following information at a minimum:

1) Manufacturers name and logo
2) Material type
3) Performance rating
4) Physical Dimensions
5) Color

c. Product information of test equipment to be used for the testing of cabling.
d. Provide documentation indicating manufacturer required and recommended maintenance and calibration services and intervals at which these services shall be performed.

1) Provide documentation indicating the dates at which all testing units have undergone these services. For services required on a daily or pre-test basis provide documentation on the procedures the contractor will undergo for performing such services.

3. Shop Drawings

a. Submit for review scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels are to be installed.
b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks to be installed (including those to accommodate 25% growth).
c. Each individual outlet on the drawings shall have proposed outlet identification indicated.
d. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.

4. Testing

a. Qualifications: Identity and qualifications of the personnel who will perform the testing as required above in the Quality Assurance paragraph.
b. Submit all physical characteristics needed for appropriate testing setup and verification. I.e. Nominal velocity of propagation (NVP) for each and every cable type. This parameter shall be identified and submitted for review. Such submittals for all parameters shall be from printed manufacturers' cut-sheets or other manufacturers' printed material.
c. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.

5. Sample warranty information as indicated herein and elsewhere in this Division.

D. Project completion submittal

1. As-built Drawings

a. Submit scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels have been installed.
b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks installed (including those to accommodate 25% growth).
c. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.

2. After approval by the Owner, submit the test results in computer readable copy in CD, DVD or mutually acceptable format by the Contractor and Owner.
3. Advanced Structured Cabling System Warranty Certificate

1.7 WARRANTIES

A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PRODUCTS AND MATERIALS

2.1 HORIZONTAL (WORK AREA) COPPER CABLE

A. Horizontal cables for dry environments

1. Requirements

a. Unshielded Twisted Pair (UTP)
b. Minimum performance specifications: Cable shall meet requirements for Category 6 and Augmented Category 6 of ANSI/TIA-568.
c. Four pairs of 22-24 AWG solid copper conductors
d. Cable jacket color(s) shall be

1) Blue for general horizontal cabling
2) Green for security cameras
3) Purple for wireless access points

e. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name
2) Copper Conductor Gauge
3) Pair Count
4) UL and CSA listing
5) Manufacturer's trade mark
6) Category rating
7) Sequential distance markings, in one foot increments

f. Individually insulated conductors under a common sheath
g. Plenum (CMP or MPP) rated.

2. Manufacturer shall be:

a. CommScope Inc.
b. Hubbell
c. Legrand/Ortronics
d. Leviton
e. Panduit
f. Seimon
g. Superior Essex Cabling
h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Horizontal cables for Wet Locations (as defined in Division 27 Section "Structured Cable System")

1. Requirements

    a. Suitable to be in contact with standing water
    b. Cable construction shall be consistent with manufacturer's requirements to be covered under warranty specified in Division 27 Section "General Communications Requirements".
    c. Minimum performance specifications: Cable shall meet requirements for Category 5e Category 6 and Augmented Category 6 of ANSI/TIA-568.
    d. Cable jacket marking: Shall be legible and shall contain the following information:

        1) Manufacturer's name
        2) Copper Conductor Gauge
        3) Pair Count
        4) UL and CSA listing
        5) Manufacturer's trade mark
        6) Category rating
        7) Sequential distance markings, in one foot increments

2. Product shall be:

    a. CommScope Inc.
    b. Hubbell
    c. Legrand/Ortronics
    d. Leviton
    e. Panduit
    f. Siemon
    g. Superior Essex Cabling
    h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.2 FACEPLATES FOR COPPER CONNECTIVITY

A. Single-gang faceplate:

1. Requirements

    a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
    b. Color shall match electrical, U.O.N. by owner
    c. Single gang, U.O.N

2. Product shall be

    a. CommScope Inc.
    b. Hubbell
    c. Legrand/Ortronics
    d. Leviton
    e. Panduit
    f. Siemon
    g. Superior Essex Cabling
    h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Double-gang faceplate:

1. Requirements

    a. Stainless steel with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
    b. Color shall match electrical, U.O.N. by owner
    c. Double gang, U.O.N

2. Product shall be

    a. CommScope Inc.
    b. Hubbell
    c. Legrand/Ortronics
    d. Leviton
    e. Panduit
    f. Siemon
    g. Superior Essex Cabling
    h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

C. Weatherproof faceplate:

1. Requirements

    a. Water resistant faceplate (to IP56 rating, or equivalent) with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
    b. With in-use cover

2. Product shall be:

    a. Panduit Mini-Com Water Resistant Faceplate with integral cover.
    b. Hubbell RW57300 (Or Approved Equivalent) with decora-insert and jacks from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements).

2.3 COPPER CONNECTIVITY

A. Modular jacks

1. Requirements

    a. Outlets shall meet requirements for Category 6 and Augmented Category 6 of ANSI/TIA-568.
    b. All 8-position modular jacks are to be wired according to the TIA T568A/B pin/pair assignments.
    c. Outlet hardware shall be UL listed.
    d. One port
    e. Color shall match electrical, U.O.N. by owner

2. Product shall be

    a. CommScope Inc.
    b. Hubbell
    c. Legrand/Ortronics
    d. Leviton

e. Panduit
f. Siemon
g. Superior Essex Cabling
h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Blank inserts

1. Requirements

a. Provide blank modules to fill any unused openings in faceplates
b. Color shall match other jack colors

2. Product shall be

a. CommScope Inc.
b. Hubbell
c. Legrand/Ortronics
d. Leviton
e. Panduit
f. Siemon
g. Superior Essex Cabling
h. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 CABLE INSTALLATION

A. General

1. Place all horizontal cabling in accordance with these specifications, on the Drawings, and as indicated on any cable schedules
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.

a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.

1) Horizontal cabling shall be terminated in a Telecommunications room that is on the same floor as the area (outlet) being served in accordance with ANSI/TIA-568.
2) No horizontal Category cables shall exceed the allowed maximum distance of 295 feet (90 meters) by ANSI/TIA-568.

3) Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.

3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system. Refer to the electrical drawings for the layout of the conduits. Refer to the Telecommunications drawings for layout of cable tray.

   a. All horizontal cables shall be plenum (CMP, MPP, OFNP, or OFCP) rated. UON
   b. Horizontal cables installed in "wet" locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.

4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

   a. Except when supported by ladder racking within each Telecommunications room, UON.

5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
7. Comply with all referenced standards and guidelines.
8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
9. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the work area outlet and one at the Telecommunications room/enclosure. Each slack/service loop shall be:

   a. A minimum of 8 feet (2.44 meter) in length, UNO
   b. Configured in a loosely formed figure eight configuration (i.e. not coiled)

10. Prior to using any cable pulling lubricants provide the Engineer with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.

B. Outside plant cable installation: for cables placed in "wet locations" or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)

1. Unlisted cables shall transition to an indoor rated cable within 50 feet (15.24 meter) of the entrance point as required the NEC.

   a. This 50 feet (15.24 meter) allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the

closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)

2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.

    a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.

4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50 feet (15.24 meter) of the transition point to indoor rated cabling in accordance with the NEC.
5. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings"

C. Horizontal (work area) Cables:

1. From the appropriate Telecommunications room, provide each work area outlet, the types and quantities of horizontal cables as described in the applicable system specification sections. Cables will leave the Telecommunications room via cable tray, conduit/sleeve or floor duct. Each cable will be terminated except for pay phone and elevator machine room junction box locations.
2. Install all horizontal cables in accordance with Division 27 Section "Common Work Results for Communications" and as indicated on the drawings.

3.3 CABLE & WIRE INSTALLATION

A. General:

1. Place all station cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.

B. Station Cables:

1. Install station cabling, outlets and jacks as detailed in the horizontal cable placement schedules and the Drawings. The typical configuration for outlets shall be two and four unshielded twisted pair (UTP) cables of 4-pairs each, unless otherwise noted on the drawings or the Horizontal Cable Placement Schedules.

C. Cables located in "wet" locations

1. Provide all required entrance protection in accordance with Division 27 "Communications Equipment Room Fittings".
2. Follow the requirements for installing outside plant rated cable as specified in Division 27 Section "Communications Horizontal Cabling"
3. All cables routed to floor boxes in the slab shall route to a transition box within 50 feet (15.24 meter) of where the conduit emerges from the slab. Provide connecting hardware within an appropriately rated enclosure to allow a transition from outside plant cable to indoor rated cable. Indoor rated cable shall be rated as required by building code and as specified herein. Route indoor cables as indicated for horizontal cable distribution.

Transition hardware shall meet or exceed the category performance of the highest rated cable being terminated.

a. Cables from multiple different floor boxes may be routed to a single, appropriately sized, transition enclosure.

3.4 CONNECTOR INSTALLATION

A. Furnish and install all cable connectors as shown on the Drawings.

B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.

C. The provision and termination of connectors from each cable shall be done as follows:

1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

D. Copper Connector Installation

1. Terminate all four pairs of each cable on one outlet jack.
2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
3. The provision and termination of connectors for each cable shall be done as follows:

a. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
b. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

3.5 FACEPLATE INSTALLATION

A. Furnish and install all faceplates in locations as shown on the Drawings.

3.6 CABLE IDENTIFICATION

A. Label all horizontal cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.

1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.

B. Cables shall be labeled within 6" at each end.

C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

1. Brady, IDXPERT
2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or equivalent

3.7 CABLE TERMINATIONS

A. Terminate all horizontal cables in accordance with Division 27 Section "Communications Equipment Room Fittings". No cables shall contain unterminated elements UON.

3.8 CABLE TESTING

A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.9 ACCEPTANCE

A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.

B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found.

END OF SECTION

SECTION 274100 - AUDIO VIDEO SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. These specifications and the associated TN series drawings describe the audio-video (AV) systems (hereafter referred to as the "Technical System") requirements to be furnished and installed as a portion of the project scope of work.

B. System is intended for robotics and locker room spaces.

C. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.

D. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.

E. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project's Architect, Structural Engineer, and Design Consultant.

F. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.

1. Provide related low-voltage "on/off" AC power control system wiring, low-voltage "on/off" control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
1. Division 27 Section "Common Work Results for Communications"
2. Division 27 Section "Communications Horizontal Cabling.

B. All Category and cabling and terminations shall adhere to the Division 27 Section "Communications Horizontal Cabling".

C. This section is a parent section to all sections numbered 274101 thru 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.

1. Exception: Division 27 "Television Distribution Systems" is a stand-alone section.

1.3 EXAMINATION OF SITE

A. This project is an existing facility undergoing expansion.

B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve this work.

C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in their proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

1.4 MATERIAL AND WORKMANSHIP

A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.

B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.

C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer's original operation, instruction, installation, and service manuals for each equipment item, for reference.

1.5 ORDINANCE AND CODES

A. Comply with all applicable national and local codes and ordinances and obtain all required permits.

B. Contractor shall be responsible for any and all violations within the scope of this work.

1.6 DEFINITIONS

A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.

B. Suspension System – A unique assembly of rated hardware elements and accessories required for overhead installation (and attachment to building structure) of loudspeakers and other technical system components. Elements of a suspension system may include: wire rope, shackles, eyebolts, chain, beam clamps, strut channel, etc.

1.7 QUALITY ASSURANCE

A. Contractor General Qualifications:

1. Compliance with the requirements of Division 1.
2. Licensed to perform work of this type in the project jurisdiction.
3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.

4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.
5. Active membership in the National Systems Contractors Association (NSCA).
6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).

    a. AVIXA APEX certification.

7. Fully staffed and equipped maintenance and repair facility.
8. Factory-authorized dealer for the major components specified.

B. Contractor Personnel Qualifications:

1. Skilled workers thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and the methods needed for proper performance of the work in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
2. Supervisor with at least five (5) years direct experience in similar work. The supervisor shall be present for and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To assure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene. This person shall act as the Technical System Project manager and shall attend all scheduled project meetings.

    a. Minimum of one full-time staff member who has attended technical system design and installation courses taught by Syn-Aud-Con in the past 10 years.
    b. Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.
    c. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
    d. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network-based AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer's certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary testing of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
    e. Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.

C. Provide additional information as required for review by the Owner's Representative, Architect, and Design Consultant to aid in proving acceptability.

1.8 SUBMITTALS

A. Refer to requirements in Division 27 Section "General Communications Requirements".

B. Include the following items specifically as it relates to AV:

1. Submittal #1: AV System Product Data (Pre-Construction). A separate product data submittal is required for each specification section, i.e., 274100, 274116, etc.

    a. Equipment List (1A)
    b. Manufacturers' cut sheets (1B)
    c. Product Substitutions (1C)
    d. Project Implementation Schedule (1D)

2. Submittal #2: AV System Shop Drawings (Pre-Construction)

    a. AV Pathways, Devices, and Cabling (2A) – Follow requirements of Division 27 Section "Common Work Results for Communications". Indicate locations of all devices and equipment.
    b. Signal Flow Shop Drawings (2B) – Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design found within the Construction Documents shall be reflected and identified. Include wire numbering scheme.
    c. AV Control System (2C) - AV control system panel/screen layouts suitable for the Owner's Representative to understand the operation and flow (submitted no less than five months prior to system first use).
    d. DSP Signal Flow (2D) - DSP signal flow configuration (submitted no less than three months prior to system first use).

3. Submittal #3: AV System Fabrication Drawings (Pre-Construction)

    a. Structural Details (3A)

        1) No Suspended device shall be installed prior to the final approval of Structural Detail Submittals by the Consultant.
        2) For Suspended equipment provide detailed, dimensioned drawings of each Suspension hardware assembly. Also indicate location relative to structure, location relative to other component(s) (Technical System or otherwise), configuration of suspended components, attachment to structure, suspension method, and calculations.

            a) Calculations shall include weights of Technical System equipment including suspension hardware, and details of all suspension hardware including: manufacturer(s), part number(s) and pertinent technical information (i.e., Working Load Limit) of each part including nuts, bolts, and other accessories. All weight bearing hardware must be traceable, load rated, and domestically manufactured. All welds must be certified.

        3) Prior to submission, these drawings must be approved and signed/sealed by a structural engineer licensed for the location of the project. The following guidelines are applicable:

            a) Contractors participating in the Suspension of Technical System components shall conform to industry best practice standards as set forth in:

i) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14); and
ii) ANSI E1.6-2 -2013 (Entertainment Technology – Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry); and
iii) ANSI E1.6-3- 2012 (Selection and Use of Serially Manufactured Chain Hoists in the Entertainment Industry).

b) All Suspended loudspeakers shall conform to ANSI E1.8-2012 (Entertainment Technology—Loudspeaker Enclosures Intended for Overhead Suspension—Classification, Manufacture and Structural Testing).

b. Equipment Rack Shop Drawings (3B) - Equipment rack front elevation for each rack showing equipment, panel layout, and electrical circuiting.
c. Panel, Patch Panel, and Plate Shop Drawings (3C) - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.
d. Millwork Shop Drawings (3D) - Sound console and mobile cart millwork details, and related equipment and panel layout (submitted no less than three months prior to the installation of other millwork).
a. Video Wall Shop Drawings (3E) – Dimensioned elevations (front and side) for each video wall showing panel layout, ancillary equipment at wall location, low voltage/signal circuiting, and electrical circuiting.

4. Submittal #4: AV System Test Results (Prior to Substantial Completion)

a. Preliminary Testing Documentation Package (4A) – Provide preliminary results of system testing as described in Part 3 of this section for review prior to final acceptance. Include final results with Closeout Documentation.

5. Project Closeout

a. Refer to Division 27 Section "General Communications Requirements" and the Record Drawings and Operation and Maintenance Data sub-sections in Part 3 of this section for requirements.

6. Refer to child sections for additional requirements.

1.9 SUBSTITUTIONS

A. Refer to Division 27 Section "General Communications Requirements".

1.10 ELECTRONIC FILE SHARING

A. Refer to Division 27 Section "General Communications Requirements" for information on obtaining electronic versions of the construction drawings.

1.11 PROTECTION OF WORK

A. Protect all work, materials, and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner's

Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.

B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminates. Clean all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system final acceptance activities.

1.12 EXISTING EQUIPMENT

A. Certain existing technical system equipment shall be re-used with the new technical system as indicated on the drawings and in these specifications. Provide any equipment not specifically noted as "existing".

B. Obtain this equipment from the Owner's Representative in a timely manner as required to coordinate with the project schedule. Verify all model numbers, quantities, sizes, and connector types as necessary to coordinate with system requirements. The Owner's Representative may elect to substitute other equipment in lieu of that listed prior to the submission of shop drawings.

C. Examine the equipment and perform normal operational checks to verify that the equipment is in good condition and is operating normally. Should any equipment defects be found (physical, electrical, or otherwise), identify, in writing to the Owner's Representative: a) defects found; and b) the estimated cost of any proposed repairs versus cost of replacement.

D. Where required for rack-mounting, furnish rack-mounting hardware or shelf for equipment not already having rack-mounting flanges. Also furnish security covers for existing equipment where such covers are required per the specifications.

E. Fully integrate the equipment with the technical system and provide all necessary signal connections and programming.

F. Proper operation and maintenance of such existing equipment remains the responsibility of the Owner's Representative.

G. Owner's existing portable equipment may be used by the Owner's Representative with the new technical systems. Proper operation and maintenance of such existing equipment remains the responsibility of the Owner's Representative.

1.13 EXISTING WIRING -REMOVAL

A. Comply with NEC (National Electrical Code) requirements regarding removal of all existing wiring that is not re-used with the system(s) defined herein.

1.14 TEMPORARY TECHNICAL SYSTEM

A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

1.15 WARRANTY

A. Warrant all work executed under this contract, including all in-shop and onsite material, parts, and labor, for a period of twelve months after the date of final acceptance.

1. Existing or any other Owner-furnished equipment shall not be included in this warranty.
2. For equipment that has an advertised manufacturer's warranty longer than 12 months, include end date of warranty period.

B. For facilities that operate on a repeating annual basis, such as educational and sports facilities, the warranty shall be 15 months.

C. The warranty services are limited to normal business hours unless additional agreements are made between the Owner's Representative and the contractor.

D. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.

E. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.

F. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

G. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period and provide the updates to the Owner's Representative and Design Consultant.

H. Refer to General Conditions for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise designated, provide all of one type of equipment from one manufacturer. For example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.

B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by substituted equipment.

C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.

D. All equipment shall be new and of professional quality.

E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.

F. Each software programmable device furnished (i.e., Digital Signal Processor, control system, etc.) shall include most recent software and appropriate computer interface (wired cable or wireless). Cable, software, source (uncompiled) code and all related aspects of all software-controlled equipment shall become the property of the Owner and will be furnished as a portion of the Operation & Maintenance (O&M) Data manuals (see Operation & Maintenance Manuals near the end of Part 3).

G. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), as well as those items associated with Alternates, are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

2.2 CABLE - BULK

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.

B. Product must be procured from the original cable manufacturer.

C. AWG wire sizes indicated herein or on the drawings are the minimum size conductors required. Larger size conductors (i.e., smaller AWG number) are permitted assuming no impact on the project will occur (such as the resulting need for larger or additional conduit, cable trays, chases, etc.) to accommodate such cable.

2.3 CABLES – FACTORY TERMINATED – INSTALLED

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.

B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Not permitted for use in conduit unless specifically noted as such.

C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section "Audio Video Systems Equipment" and are required to be furnished in addition to those required for system installation.

D. All cable assemblies must be factory tested and certified.

E. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1'-25':

1. Belden HD-800 Series (2', 4', 8', 25'); or
2. Clark Wire HDMI-L Series (3', 6', 10', 16'); or
3. Perfect Path 800 Series (2', 4', 8', 16', 25'); or
4. Approved Equal.
5.

2.4 ACTIVE ELECTRONICS – INSTALLED

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.

B. Factory HDMI extenders specified in this subsection are only permitted for use at interface plate locations that exceed 45' between the presentation device and display and/or projector.

C. HDMI Category 6 extension devices to power HDMI signals to extend past 45' in distance:

1. Extron
2. Kramer
3. C2G
4. StarTech
5. Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 PREPARATION

A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.

B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.

1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

3.3 INSTALLATION

A. General

1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.
2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.

B. Suspended Systems

1. General

a. Contractor shall provide Suspension system, including connection to structure, for all suspended components including but not limited to: loudspeakers, video projectors, flat panel displays, televisions, projection screens, etc.
b. Suspension system design shall be created by the Contractor and include fully dimensioned detail documentation stamped by a structural engineer licensed in the location of the project per submittal requirements in Part 1 of this document.
c. Contractor shall include a safety cable or other backup support mechanism.
d. Suspension systems and installation shall conform to industry best practice standards as set forth in:

1) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14)

e. Coordinate with General Contractor any supplemental building structure necessary to facilitate the approved suspension design.
f. Field verify conditions for compliance with the approved suspension plan prior to installation, placement of equipment orders, or material fabrication. Coordinate with other trades as necessary.

2. system requirements.

3.4 CABLE MANAGEMENT AND TERMINATION

A. Employ techniques to fulfill AVIXA F502.01:2019 "Rack Building for Audiovisual Systems" as a minimum standard with the additional requirements as described in this paragraph.

1. Reference below for additional requirements and stipulations related to zip tie utilization.

B. General

1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.
2. Dress cables so terminations are free from stress due to gravity acting on the cabling. Use cable supports as required depending on the size and stiffness of the cable.
3. Terminate cables with sufficient service loop to allow at least two re-terminations without having to open a cable bundle or pathway.

3.5 LABELING

A. Adhere to AVIXA F501.01:2015 "Cable Labeling for Audiovisual Systems" as a minimum standard with additional requirements as described in this paragraph.

B. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for all labeling requirements associated with data-related cabling including Category and Fiber Optic cabling.

C. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.

D. Document the labeling standard for inclusion in the Operation and Maintenance Data.

E. Document all labels for the Record Drawings.

F. Pre-approved labelling systems include:

1. Brother P-touch EDGE with HGeS2***PK labels; or
2. Brady Equipment Identification Labels.

3.6 CONTRACTOR'S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.

B. The Contractor shall submit the results of all tests prior to on-site system review by the Design Consultant. Where available, provide documentation obtained directly from the test equipment. Other acceptable documentation includes screen captures, photos, and spreadsheets.

C. General

1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.
2. All test equipment used for these tests shall be on site during the system final acceptance activities should verification of submitted measurements be required.
3. Ensure that all equipment is on the jobsite and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.
4. The functional tests shall include operational tests of all program source equipment (record and playback), wireless microphone system, mixing console, system inputs and outputs, all patch panel receptacles, intercom system, video routing, video distribution, operational controls, AC power sequencing, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.
5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.
6. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

D. Required testing equipment

1. Certain systems/subsystems require testing and documentation via approved test equipment.

    a. Systems requiring testing via approved devices will be identified below.
    b. Required test devices will be listed in related sections.
    c. Provide unified testing results of similar systems. Describe testing procedure including all test equipment used.
    d. Provide original results from testing equipment (as applicable).

2. Failure to submit testing documentation conducted via approved devices will result in delayed final acceptance by the Design Consultant.
3. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.

3.7 FINAL ACCEPTANCE

A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site acceptance of the technical system. This process will include, but not be limited to the following, as applicable:

1. Random verification of contractor tests
2. System check-out
3. Tailoring of the technical system's frequency response to the facility's acoustical environment (where required)
4. Observation of video system to verify proper image display
5. Function and operability of the control system.

B. Provide the services of the designated supervisor and any other technicians who are familiar with the system, for approximately four two hour. Additional time may be required due to Alternates accepted by the Owner's Representative, or due to Addenda or Change Orders (if any) which modify the scope of work. The supervisor shall provide personal assistance during these activities. This duration does not include time for correcting wiring errors, equipment malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.

C. At the completion of the final acceptance period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.

D. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers' original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.

E. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner's Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner's Representative.

F. Provide operational assistance for the first major use of the completed system as directed by the Owner's Representative, including being present for: one prior rehearsal associated with the event (if applicable); a technical check immediately prior to the event; and the event itself.

3.8 OPERATION AND MAINTENANCE DATA

A. At the completion of the project, compile thorough copies of the Operation and Maintenance (O&M) Data per Division 27 Section "General Communications Requirements".

B. O&M data shall be assembled according to rooms or areas as it relates to the project site. The intent is to allow the Owner's Representative to easily locate information relating to a specific system/room without having to spend an inordinate amount of time searching. Include complete information for each system/room – this may involve duplication of information.

C. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.

D. As applicable, save full digital version to the system computer.

END OF SECTION 274100

SECTION 275123 - INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. System Description

B. Cone-Type Loudspeakers

C. Conductors and Cables

1.2 RELATED REQUIREMENTS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Section 270010 General Communications Requirements.

1.3 REFERENCE STANDARDS

A. - Communications Systems for Life Safety in Schools; January 29, 2015.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 1480 - Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.

D. UL 60950 - Safety of information technology equipment; current.

E. UL 813 - Standard for Commercial Audio Equipment; current.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. Pre-bid submittal:

1. For all products for which an alternate product is desired to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

B. Pre-construction submittal:

1. Submit Shop Drawings.

   a. Submit layout drawings of the communication system and all components. Indicate wiring type and proposed routing to each device.
   b. Submit drawings of control equipment showing all major components and positions in the rack.
   c. Provide block diagrams showing components and relative connections and proposed zones.
   d. Submit amplifier sizing calculations.

2. Submit the complete list of materials proposed for this work in accordance with Specification

   a. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters)

3. Submit manufacturers cut sheets or catalog cut sheets of each of the components to be used for products not specifically identified herein by exact part number.
4. Submit manufacturer's data on paging systems and accessories.
5. Submit data sheets on equipment provided.

C. Project completion submittal:

1. As-Builts

   a. Submit layout drawings of paging system including speakers, head-end equipment, volume controls and other accessories. Indicate wiring sizes and routing to each device.
   b. Submit drawings of control equipment showing all major components and positions in the rack.
   c. Provide block diagrams showing components and relative connections and zones.

2. Submit data sheets on equipment provided.
3. Installation wiring diagrams and instruction manuals
4. Submit a certificate showing a completion of installation, programming, and service training from the system manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

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

D. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

E. All manufactured equipment shall be installed as recommended by the manufacturers, or as indicated in their published installation manual.

1.7 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

B. Manufacturers: Subject to compliance with requirements, provide products from one of the following, unless specified otherwise.
   1. Loudspeakers, Horns, Call Switch, and Volume Control
      a. Atlas Sound
      b. Bogen
      c. Carehawk
      d. JBL
      e. Lowell
      f. OWI Incorporated
      g. Quam
      h. Pure Resonance
      i. Soundtube
      j. Telecor
      k. TOA
      l. Valcom
      m. Yorkville
   2. Substitution: See Section 016000 - Product Requirements
      a. Substitutions will not be considered unless formally submitted during the bidding process as an RFI. If accepted, product will be added in an Addendum.

2.2 RENOVATION OR ADDITION OF EXISTING SYSTEM

A. The existing systems and scope of work
   1. The intercommunications and program system is <insert system>.
   2. Revise existing system to address the room reconfigurations. Expand existing system to new addition spaces.
      a. Notify school district and design team if parts are discontinued and cannot be sourced new.
      b. If only used parts are available, notify the school district and design team

B. Speakers

1. Match existing speakers or provide equivalent if existing speaker is not available.

C. Call Switch

1. Match existing call switch or provide equivalent if existing call switch is not available.

D. Volume Control

1. Match existing volume control or provide equivalent if existing volume control is not available.

E. Clock

1. Match existing clock or provide equivalent if existing clock is not available.

F. Wiring

1. All wiring shall be listed for the intended purpose. The intercom shall use manufacture recommended cable type or better U.L. listed cable. All classrooms shall be homerun to location indicated on drawings.
2. Wire color shall match existing.
3. All interior wiring shall be in accordance with new construction guidelines suggested by the Manufacturer; including the speaker and the call-in switch.
4. Wiring shall be in accordance with the Manufacturer's specifications. Wiring shall meet all local and state codes. All wiring shall be ground and short tested.
5. Wiring shall be listed for plenum environment.

2.3 SYSTEM DESCRIPTION

A. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz in a satisfactory manner without the requirement of any external power conditioning equipment. Comply with UL 813.

B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.

C. Integration: Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.

E. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

F. Self-contained microprocessor-controlled analog system shall support education intercommunication requirements. Required features include the following:

1. Station Capacity: 240
2. Station Types: Administrative, Enhanced Staff, Staff
3. Classroom Stations: Phone or Call-in Switches
4. Multiple simultaneous private and amplified voice communications
5. Telephonic funcutions: hold, conference call, call forward, and call transfer

6. Software-based Paging Zones: 8
7. Hard-Wired Paging Zones: 240
8. Bell Schedules: 7
9. Time Signaling tones: 4
10. Programmable events: 1024
11. 911 integration

2.4 CONE-TYPE LOUDSPEAKERS

A. Comply with:

1. UL 1480 for Accessible lay-in Ceiling Speakers

B. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.

C. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.

D. Minimum Dispersion Angle: 100 degrees.

E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

F. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.

G. Baffle: For flush speakers, minimum thickness of 0.032-inch (0.8-mm) aluminum with textured white finish.

H. Vandal-Proof, High-Strength Baffle shall be located in the Cafeteria, Multipurpose rooms, and locker rooms: For flush and surface-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi (303 MN/sq. m), 0.025-inch (0.65-mm) minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.

I. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.

J. Operation

1. Two-Way: Rooms with call switch unit, such as classrooms.
2. One-Way: Spaces without call switch unit, such as corridors.

K. Speaker Types

1. Accessible lay-in Ceiling: Lay-in ceiling tile speaker assembly
2. Hard Ceiling: Recessed can speakers
3. Exposed Ceilings (excludes horn-type locations): Surface mount square speakers

2.5 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.

B. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.

C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.

1. Minimum Shielding Coverage on Conductors: 60 percent.

D. Plenum Cable: Listed and labeled for plenum installation.

2.6 RACEWAYS

A. Educational Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 270500 - Common Work Results for Communications.

B. Educational Intercommunication and Program System Raceways and Boxes: Comply with requirements for electrical branch circuits specified in Section 270500 - Common Work Results for Communications.

C. Educational Intercommunication and Program System Raceways and Boxes:

1. Raceways: EMT.
2. Boxes:

a. NEMA 3R
b. Galvanized steel.

3. Faceplates:

a. Stainless Steel with Torx screws for all exposed fasteners.

4. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

D. Flexible metal conduit is prohibited

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions

1. Verify receptacles are available to power the system.
2. Verify pathways are acceptable prior to installing cables.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General

1. Install in accordance with manufacturer's instructions.

2. Contract documents are detailed only to the extent required to show design intent. It shall be understood and agreed upon by the Contractor that all work described herein shall be complete in every detail.
3. Furnish additional items not mentioned herein to meet requirements as specified without claim for additional payments. Items, may include hardware, rack panels, 66-style Termination Blocks etc., and other devices that are required for installation.

    a. Furnish and install necessary equipment, back boxes, supports and enclosures.
    b. Furnish and install all necessary wire.
    c. All work shall be performed and completed in a thorough and workmanlike manner and in accordance with the manufacturer's instructions.
    d. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
    e. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
    f. Weatherproofing: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
    g. Connect wiring according to Section 260519 - Low-Voltage Electrical Power Conductors and Cables.
    h. Mounting of Stations: Surface mount at 46 inches above finished floor to center of station unless otherwise indicated.
    i. Provide physical isolation from speaker microphone, telephone, line level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

B. Wiring Methods

1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

    a. Install plenum cable in environmental air spaces, including plenum ceilings.
    b. Comply with requirements for raceways and boxes specified in Section 270528 – Common Work Results for Communications.

2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Installation of Cables

1. Comply with NECA 1.
2. General Requirements:

    a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
    b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

c. 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.
d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
e. 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.
f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

3. Open-Cable Installation:

a. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
b. Suspend cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. GROUNDING

1. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
2. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
3. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.
4. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
5. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
6. Install grounding electrodes as specified in Section 270500 - Common Work Results for Communications.

E. SYSTEM PROGRAMMING

1. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing educational intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
    b. Repeat test for three speaker microphones, one administrative console microphone, and for each separately controlled zone of paging loudspeakers.
    c. Minimum acceptable ratio is 45 dB.

6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom, paging, and all-call amplifier. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
8. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Section 270500 - Common Work Results for Communications.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

E. Educational intercommunications and program systems will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform systems startup.

B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

C. Perform programming of system and audio level adjustments.

3.5 CLEANING

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

3.6 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements, for commissioning requirements.

B. Test electrical grounding for compliance with requirements of authorities having jurisdiction.

C. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.
2. Conduct walking tour of project.
3. Briefly describe function, operation, and maintenance of each component.

E. Training:

1. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
2. The training program shall be implemented by a staff member/trainer employed by the system installer. The trainer must be factory certified to provide training on their product. The trainer must be a Crisis Communications Automation Specialist who will work with the district to help them utilize the system to support the individual school crisis plans set by the district.
3. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

3.8 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide a separate maintenance contract for specified maintenance service.

END OF SECTION 275123

SECTION 275313 - WIRELESS CLOCK SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Provide a complete wireless clock system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate the system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and coordination/registration of an FCC license.

B. System Description

1. System shall continually wirelessly synchronize clocks and/or timers, and shall be capable of clock readouts in multiple time zones where desired.
2. System shall operate on a 72MHz frequency. The 72MHz frequency transmitter efficiently sends time synchronization signals through commercial building materials to ensure all devices receive important time updates, even for Daylight Saving Time and after a power outage.
3. The system transmitters can be configured with a variety of power output levels to provide coverage for a single building or an entire campus.
4. The system supports an FCC license for operation of a 72MHz transmitter result in safe and interference free operation for users.
5. System shall provide wireless time from a master time source. This time source will either be the atomic clock on the GPS system or the clock from a defined NTP server that the XR transmitter can access via the customer Local Area Network (LAN). The master time will be synchronized to UTC.
6. Hard wiring for data communication will not be required to the clocks installed for the system.
7. Clocks shall automatically adjust for Daylight Saving Time in locations where DST is observed.
8. Each clock and/or timer and every other component in the system shall use both precise time and synchronized time.
9. Digital clocks shall be synchronized to within 10 milliseconds every 10 minutes and the system shall have an internal oscillator that maintains plus or minus four seconds per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
10. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day when operating clock strikes 2:01 AM, 6:01 AM, 10:01 AM, 2:01 PM, 6:01 PM, and 10:01 PM, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
11. The system shall include an internal clock reference so that failure to detect the master time source shall not result in the clocks failing to indicate time. Additionally, XR transmitters will have an internal battery backup of up to eight hours in the event of a power failure so that settings and the correct master time will be instantly recalled upon restoration of power.
12. System shall incorporate a "fail-safe" design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.

13. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will "five step" as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
14. Clock locations shall be as indicated and clocks shall be fully portable, capable of being relocated at any time.
15. System shall operate in accordance with a "Radio Station Authorization", Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

C. System Components:

1. Transmitter (Master)
2. Satellite Transmitter
3. GPS Receiver
4. System Devices:

    a. Analog Clocks
    b. Digital Clocks

1.2 RELATED DOCUMENTS

A. Division 27 Section "General Communications Requirements" details general requirements that work under this section shall follow.

B. Division 27 Section "Common Work Results for Communications" details general grounding and bonding, pathways, firestopping, access panel, and identification requirements that work under this section shall follow.

1.3 CODES, REFERENCES AND STANDARDS

A. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to:

1. The full list of Codes, References, and Standards in Division 27 "General Communications Requirements".

1.4 DEFINITIONS

A. GPS: Global Positioning System, a worldwide system that employs a constellation of satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits Universal Coordinated Time, the world's most accurate and reliable time.

B. NTP: Network Time Protocol, used for synchronizing the clocks on computer networks and devices from either a public server or a separate server on a private local area network.

C. PoE: Power-over-Ethernet

D. UTC: Universal Coordinated Time

1.5 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of manufacturer latest model.

B. System shall be installed in compliance with local and state authorities having jurisdiction.

C. U.S. only: The end user will hold a license, known as a "Radio Station Authorization" granted by the FCC. This license grants the end user protected use for wireless transmission at the designated frequency. This license will designate a unique "call sign" for each end user.

D. U.S. only: Transmitter and receiver shall comply with Part 90 of FCC rules as follows: This device may not cause harmful interference. This device shall accept interference received, including interference that may cause undesired operation. Transmitter frequency shall be governed by FCC Part 90.35. Transmitter output power shall be governed by FCC Part 90 257 (b).

1.6 QUALITY ASSURANCE

A. Warranty

1. Refer to Division 27 section "General Communications Requirements" for standard one year warranty requirements from date of Substantial Completion.
2. Include a 3-year, extended warranty from the clock system manufacturer, which shall include all parts and labor for the duration of the warranty.

1.7 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements".

B. The following submittals are due at the "pre-bid" phase submission:

1. Alternate manufacturers or system for approval

C. The following submittals are due at the "pre-construction" phase submission:

1. Parts List (Bill-of-Materials): Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
2. Submit manufacturers' cut sheets or catalog cut sheets:

    a. Cut sheets shall include the following information at a minimum:

        1) Manufacturers name and logo
        2) Product to be installed, with specific product highlighted or otherwise indicated.
        3) Size – including physical and loading dimensions.

3. Operating License (US only): Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license shall be delivered to the Owner/End User.
4. Shop Drawings:

a. In accordance with Division 27 Section "Common Work Results for Communications", submit for review scaled layout drawings showing:

1) the size/routing of all pathways
2) the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
3) Identify submittal as "Common Work for Clock Systems - Shop Drawings", unless combined with other Common Work in Division 27.

b. Submit for review as part of "275313 Clock System - Shop Drawings":

1) Riser diagram of Clock System
2) Scaled layout drawings showing system components:

a) Antenna location(s)
b) Cable routing, with cable type identified
c) Clock types/locations
d) Active/Headend equipment locations

D. The following submittals are due at the "Project Completion" phase submission:

1. Record Drawings:

a. Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Division 27 Section "General Communications Requirements".

2. Operation and Maintenance Manuals, to include:

a. Bill-of-Materials (updated, if necessary)
b. Manufacturer cutsheets of all products
c. Operation and Maintenance Manuals of all products

3. Operating License: FCC Radio Station Authorization
4. Training / Instruction of Owner on the use and programming of the system.

1.8 COORDINATION

A. Clocks and/or Timers shall not be installed until painting and other finish work in each room is complete.

B. Programmable Count Down Timers: a computer having the specified minimum system requirements for the scheduling software installation will be available for use in programming the timer. Coordinate with Owner during construction.

C. Transmitter - External Antenna: Coordinate installation of system antenna for access to the roof to comply with safety standards detailed in manufacturer instructions and per local codes.

D. For Network Time Protocol, coordinate with Owner's IT Representative.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. With the exception of cabling, all products of the Clock System shall be from the same manufacturer, unless otherwise noted.

B. Master Time Source Operation
1. NTP Time Source: With the transmitter in NTP mode, it connects over the Ethernet to the IP address of the NTP server. This IP address is programmed into the transmitter as part of its configuration. Once the connection to the NTP server is acknowledged, it downloads time data and synchronizes its internal master clock to NTP time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock in this mode once per hour.

C. The following manufacturers are conditionally approved:

1. Primex Wireless www.primexwireless.com
2. Sapling Clocks
3. Approved equivalent, submitted prior to bid in accordance with Division 27 section "General Communications Requirements".

2.2 TRANSMITTER EQUIPMENT

A. 1 Watt Transmitter

1. The transmitter shall meet all of the below specifications:

a. Transmission Frequency Ranges – 72.020 to 72.980 MHz
b. Maximum transmission: 1 watt (30dBm) maximum at transmitter
c. Operating Range: 32°F - 122°F (0° - 50°C)
d. Power: 120 VAC 60 Hz
e. Internal Antenna
f. Channels:

1) 16 selectable channels (for 14000, 14000E, or 14143 series transmitters)

g. Time Source:

1) Transmitter will allow for either NTP time input or GPS satellite time input with use of a GPS Receiver unit.
2) Unit shall obtain current time from either satellite via GPS or via NTP through an Ethernet port.

2. Internal Antenna Model only: Transmitter shall transmit time continuously to all clocks in the system.
3. Internal clock: Transmitter shall contain an internal clock such that failure to update time from source will not disable the operation of the clocks.
4. Transmitter shall include a surge suppressor/battery backup and a mounting shelf.
5. Transmitter shall have the following switches

a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.

b. Switch to allow the following configuration: Daylight Saving Time bypass option, 12-hour or 24-hour display, GPS or NTP time source, Local or LAN configuration, UTC+ or UTC-, 30 minute UTC offset option CANADA (for Newfoundland).

6. Transmitter housing shall incorporate a display, which shall include the following:

a. Time readout
b. AM and PM indicator if 12-hour time display is set
c. Day and date readout
d. Time zone indicator including Standard or Daylight Savings Time
e. On screen menu to verify diagnostics, errors, time updates, and switch settings, toggled by sequence of push buttons next to display.
f. Status LEDs: The LED signal indicator consists of three visual LEDs that indicate the status of the transmitter. The green LED indicates one of the three statuses, including (1) solid green: transmitter is transmitting, (2) not illuminated: transmitter has not received an initial time signal after power up and/or reset, and (3) flashing: transmitter is not broadcasting due to standby mode or there is a condition that is causing the transmitter not to broadcast properly. The yellow LED indicates one of the two statuses, including (1) not illuminated: no warning conditions, (2) flashing: transmitter has not received a time update for 48 hours or a 1PPS (one pulse per second) has not been detected within the last 48 hours. The red LED indicates one status, (1) solid red: defined error condition exists.

7. Install in Telecommunications Room.
8. Manufacturer shall be:

a. For coverage up to 100,000 sq. ft., on average: Primex Wireless – 1-Watt Transmitter – Internal Antenna 16-channel – 14000 Series
b. Or equivalent from Sapling

2.3 SOFTWARE

A. Software shall be compatible with the following PC operating systems: Windows XP, Windows Vista, Windows 7.

B. Owner will provide access to a PC with valid administrator rights. Install the software and program the Clock System per Owner's direction. Program system in the presence of Owner's representative and provide instruction/training.

C. A copy of the software shall be provided from manufacturer in a form of a CD, suitable for operation in standard CD-ROM drives.

2.4 ANALOG CLOCKS

A. Analog clocks shall be wall mounted, as indicated on the drawings.

B. Face shall be white. Hour and minute hands shall be black.

1. Additional colors, finishes, and dial faces are available from manufacturer.
2. Clock faces can be customized by manufacturer to display organization name or logo if desired by owner or architect.

C. Clock frames and lenses are of durable thermoplastic.

D. Size and frame color shall be:

1. Standard Battery Models 12.5" black

E. Provide optional wire guard accessory where clocks are susceptible to accidental damage, including, but not limited to:

1. Robotics
2. Manufacturing areas

F. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.

G. Clock shall have a battery-power power supply built into the clock assembly.

1. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self-correct to the current time.
2. Battery-operated analog clocks shall have up to a 5-year battery life.
3. Installer will furnish clock batteries in accordance with manufacturer instructions.
4. Battery-operated analog clocks shall remember the time during changing of batteries.

H. Time shall be automatically updated from the transmitter 6 times per day.

I. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 96 hours, the second hand will "five -step" as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.

J. Analog clock receivers shall be as follows:

1. Receiver sensitivity: >-110 dBm,
2. Antenna type: internal, Antenna gain: -7 dBd

K. Manufacturer shall be:

1. Primex Wireless
2. Sapling

2.5 DIGITAL CLOCKS

A. Digital Clocks shall be able to receive synchronized time signal from the master or satellite transmitter.

B. Digital Clock display shall include a 12 or 24-hour time display, a PM indicator light, and an alternating time and date display option.

C. Digital Clock shall be capable of automatically adjusting for Daylight Saving Time.

D. Digital Clock shall have either a 120 VAC power supply built into the clock assembly.

1. 120 VAC Digital Timer shall include a 9-foot power cord (minimum) with a three prong plug or a 18" (45.72cm) cord with pigtail.

E. Digital clocks shall be viewable from 150 feet.

F. Digital clocks shall have highly visible 7-segment LED digits.

G. Digital clock shall have three display dimmer options, 75%, 50%, and 25%.

H. Model shall be dual-mount with 2.5 inch tall digits:
   1. Ceiling - 18" cord with pigtail, 120 VAC

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 GENERAL

A. All conduit routing and junction boxes for the Clock System shall be accurately identified on shop drawings and final record drawings. Refer to Division 27 Section "Common Work Results for Communication" for additional requirements.

B. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.

C. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

D. AC-powered devices: Verify that electrical power outlet is near location of clock or timer and the outlet is operational and properly grounded.

E. Install system in accordance with applicable codes.

F. Install system equipment in accordance with manufacturer written instructions.

G. Provide all system equipment necessary for a complete and operable system.

3.3 MASTER TIME SOURCE – NTP

A. Connect CAT5e/CAT6 EIA/TIA standard Ethernet cable from transmitter LAN port to available network drop.

   1. The network drop used to connect the XR transmitter shall have connectivity to the NTP server, which can be verified by the owner's Information Technology department manager. The default NTP address is time.nist.gov. If the network has a different NTP IP address, it shall be programmed into the transmitter by the installer to allow connection to the proper network time.

B. Set GPS/LAN DIP switch to NTP.

3.4 TRANSMITTER – INTERNAL ANTENNA

A. Locate transmitter where indicated, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.

B. Transmitter(s) shall be placed at locations indicated within specifications and drawings.

C. Connect antenna to transmitter, using care not to strip threads.

D. Connect power supply to the transmitter.

E. Set the channel number on the display to correspond to the FCC license.

F. Plug power supply into electrical outlet.

3.5 ANALOG CLOCKS

A. Furnish all equipment necessary for a complete and operational system.

B. Perform the following operations with each clock:

1. Configure and set clock to correct time in accordance with manufacturer's instructions.
2. Observe clock until valid signals are received and clock adjusts itself to correct time.
3. Install each clock per its model mounting specifications per manufacturer instructions and mounting instructions at the indicated location.

3.6 DIGITAL CLOCKS

A. Cable routing shall comply with TIA-569-B and local building codes.

B. Furnish all equipment necessary for a complete and operational system.

C. Perform the following operations with each clock:

1. Configure and set clock to correct time in accordance with manufacturer's instructions.
2. Observe clock until valid signals are received and clock adjusts itself to correct time.
3. Install each clock per its model mounting specifications per manufacturer instructions and mounting instructions at the indicated location.

3.7 WIRE GUARDS

A. Secure to wall, using approved theft-resistant fasteners.

3.8 LABELING

A. Submit proposed labeling scheme for transmitter(s), clocks, and cabling, identifying each component and label on the shop drawings.

B. All cables shall be labeled within 6" of each end.

C. Where applicable, label back of each clock with accepted identification/label.

D. Label cover of any junction box utilized for clock system conduit/cabling with "Clock System J-Box".

3.9 COMMISSIONING/TESTING

A. Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts which are found defective. Also, clean exposed surfaces of devices, using cleaning methods recommended by manufacturer.

B. All devices shall be tested at their operational location under normal operational conditions to assure reception of signal.

C. Protect finished installation until final acceptance of the project.

3.10 TRAINING

A. Provide training to Owner's representative on setting, adjusting and configuring device and routine maintenance.

B. Provide training to Owner's representative on installing the software, adjusting and programming the transmitter, setting and adjusting system devices and routine maintenance.

3.11 PROJECT COMPLETION – CLOSE OUT DOCUMENTS

A. Provide "Project Completion" submittal requirements as outlined in Division 27 Section "General Communications Requirements" and the submittal requirements earlier in this section.

END OF SECTION 275313

SECTION 280010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

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 and to all following sections within Division 28.

1.2 DESCRIPTION OF WORK

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 28 of these Specifications, and Drawings numbered with prefixes TY, generally describe these systems, but the scope of the Electronic Safety & Security Work includes all such Work indicated in all the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications, along with the device schedules located on drawing legend sheets, define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 ABBREVIATIONS

ADA	Americans with Disabilities Act
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ETL	Electrical Testing Laboratories, Inc.
FCC	Federal Communications Commission
FM	Factory Mutual
IEEE	Institute of Electrical and Electronic Engineers
LED	Light Emitting Diode

NEC	National Electric Code
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NRTL	Nationally Recognized Testing Laboratory
OEM	Original Equipment Manufacturer
OFCI	Owner Furnished Contractor Installed
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories
UON	Unless Otherwise Noted

1.4 QUALITY ASSURANCE

A. Execute all Work under this Division in a thorough and professional manner by competent and experienced work persons duly trained to perform the Work specified.

B. Qualifications – refer to individual Division 28 sections for specific Personnel and Contractor Qualifications.

C. Install all Work in strict conformance with all manufacturers' requirements and recommendations unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation.

D. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer.

E. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

F. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations and requirements of the service providers serving the project and the Owner's insurance underwriter.

G. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the most stringent apply.

H. Should any change in drawings or specifications be required to comply with governing regulations, notify and receive written approval from the Architect prior to submitting bid.

I. All equipment and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, NEC, NEMA, NFPA, OSHA, UL, and the State Fire Marshall.

J. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced, full-time Project Manager who is authorized to make decisions on behalf of the Contractor.

K. Warranty Requirements

1. Refer to Division 1 and General Conditions for Warranties.

2. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a minimum period of 12 months from date of Substantial Completion, or longer where specific items are required to carry a longer warranty in these Construction Documents or a manufacturer's standard warranty exceeds the minimum. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 1.
3. Refer to individual Division 28 sections for additional warranty requirements, as certain components and systems will have warranty requirements that exceed 12 months.
4. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
5. Schedule repairs with the Owner for times of the day, days of the week as specified by the Owner. No premiums shall be charged to the Owner for work requiring weekend or after "normal business hours" access.
6. Perform the remedial work within 48 hours, upon written notice from the Architect or Owner, unless deferred by the Owner.
7. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.5 CODES, REFERENCES, AND STANDARDS

A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes.

B. Bring all perceived conflicts between codes, ordinances, rules, regulations and these documents to the Architect's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

1. If a conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Architect and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes. Refer to individual sections for exact codes, references, and standards.

1.6 DEFINITIONS:

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
2. Approved - Labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
3. As Directed - As directed by the Architect, or his representative.
4. Concealed - Embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
5. Conditionally Approved – The manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
6. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions.
7. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
8. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division."
9. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
10. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
11. Provide - "To furnish and install complete, and ready for the intended use."
12. Prime Contractor – a project's overall contractor responsible for all Divisions of Work, usually identified as a General Contractor or Construction Manager At Risk.
13. Submit - Submit to Architect for review.
14. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

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

15. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal

of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

16. Wet Location - A location subject to saturation with water or other liquids. Pathways installed in wet locations do not protect cables from moisture such that cables installed in pathways within wet locations must be identified by their manufacturer for use in wet locations.

    a. For example: Slab-on-grade construction where pathways are installed underground or in or under concrete slabs that are in direct or indirect contact with soil (e.g., sand and gravel with or without a moisture barrier) is considered a "wet location."

17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by, or acceptable to, the Design Consultant as equivalent to the item or manufacturer specified".

1.7 COORDINATION

A. Coordinate with other Divisions for Electronic Safety and Security work to be included but not listed in Division 28 or indicated on the Security or Fire Alarm Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make do provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.

C. Refer to Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit.

D. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite always to coordinate this Work with other trades so that various components of the Division 28 systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.

E. Execute the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 1 and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule to ensure successful achievement of all schedule dates.

G. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.

H. Refer to Coordination requirements in specific sections for additional information.

I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades and report any discrepancies between them to the Architect and obtain written instructions for changes necessary in the work. Install and coordinate the work in

cooperation with other related trades. Before installation, make proper provisions to avoid interferences.

J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.

K. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.

L. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Architect.

1.8 MEASUREMENTS AND LAYOUTS

A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.9 SUBMITTALS

A. Refer to Division 1 and General Conditions for general submittal requirements in addition to requirements specified in this section. Refer to individual Division 28 Sections for additional submittal requirements. Unless otherwise noted, it is acceptable to submit electronic, PDF files.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

D. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct submittal stages:

1. "Pre-bid" Submittal

    a. Generally means submittals required no less than two weeks prior to the due date for the submission of bids, such as:

        1) Product substitutions approved alternate or equivalent requests to be reviewed for approval (Prior to Bid). Coordinate with Division 1.
        2) Alternate personnel credentials to be reviewed for approval

2. "Bid" Submittal

    a. Generally means submittals required at the time of the submission of bids, such as:

1) Personnel Qualifications
2) Contractor Qualifications

3. "Pre-Construction" Submittal

a. Generally means submittals required after the award of the project to the winning bidder and prior to starting construction. At a minimum, Pre-Construction submittals shall include:

1) The project name
2) The submitted contractor's company name, the individual's name responsible for the submittal, and contact information for that individual
3) The Prime Contractor's stamp, which shall certify that the stamped submittals have been check by the Prime Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

b. Submittals for this division shall be divided and titled in the following manner:

1) Division 28 Electronic Security Systems

c. Submit the following items within 4 weeks after the notice to proceed:

1) Division of Labor amongst sub-contractors. Include:

a) Information on each sub-contractor:

i) Company Name
ii) Address
iii) Name of project manager for this project, including:

(1) E-mail
(2) Telephone number

b) A detailed description or matrix identifying who is responsible for furnishing, installing, and verifying the following system components:

i) General requirements:

(1) Various system power, backup power, and grounding/bonding items.
(2) Various conduit and other common work items.
(3) Various low-voltage wires/cabling and terminations.
(4) Various structural and seismic items (including design)

ii) Individual Division 28 sections

2) Updated Personnel and Contractor Qualifications (resubmit if there are no changes)
3) Schedule - A Gantt chart or Milestone list that includes the following timetables:

a) Pre-Construction Submittals

i) Include time for resubmittals

ii) Unless otherwise stated elsewhere within these specifications, assume 1 week review time for the Prime Contractor and 2 weeks for the Architect/Division 28 Design Consultant for each submittal.

b) Material purchase/shipping schedules (to identify any long lead times for critical components)
c) Conduit Installation
d) Cabling Installation
e) Cabling termination and testing
f) Power and backup power availability
g) Equipment installation and testing
h) System startup and configuration
i) As-built drawings
j) Operation and Maintenance Manual submission, resubmission, and approval
k) Final Site Observation for Substantial Completion approval to be at least 2 weeks prior to overall project Substantial Completion date
l) Owner Training sessions
m) Other items as required by individual sections in this Division

4) Equipment List - A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
5) Data Sheets - Manufacturers' datasheets:

a) At a minimum all product datasheets shall contain the following:

i) The manufacturers' name and logo somewhere on the page
ii) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
iii) For datasheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
iv) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

b) Datasheets are to be in the same sequential order as is presented within the specifications.

6) Warranty Information – For warranties required by this specification and other Related Sections, submit warranty terms and conditions for each system or product. These shall contain the following:

a) Length of warranty period
b) What is covered
c) All disclaimers, limitations, etc.
d) What, if anything, is not covered?

7) Samples – refer to individual sections for exact sample requirements.

a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer is to cover return shipping if sample is to be returned.

8) Shop Drawings – Refer to individual sections for exact Shop Drawing requirements.

d. And as required by individual sections in this Division

4. "Project Completion" Submittal

a. Generally means, unless otherwise noted, submittals required to be submitted 4 weeks prior to Substantial Completion, for the Design Consultant to reference during the "Final Punch" Site Observation. Project Completion, aka "Close-out Documents" include the following:

1) Record Drawings
2) Operation and Maintenance Manuals – refer to "Operations and Maintenance Data" section below.
3) Owner training syllabus
4) Recorded Owner Training
5) Project test reports
6) Cable Databases (as applicable)
7) Warranty Certificate(s)
8) And as required by individual sections within this Division

E. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Design Consultant that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Design Consultant's designated representatives. Contractor shall allow the Design Consultant review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

F. Identify each sheet of printed submittal pages (using arrows, highlighting, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options being proposed. Cross out or line-through non-applicable information. Note specified features such as materials or paint finish.

G. Provide submittals in sufficient detail to demonstrate compliance with these Contract Documents and the design concept.

H. Transmit submittals as early as required to support the project schedule. Allow two weeks Design Consultant review time, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.

I. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.

J. Before transmitting submittals and material lists, verify that the equipment submitted is compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.

L. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:

1. The project name
2. The applicable Specification Section
3. The submittal date
4. The submitting contractor's company name and the project manager's name and contact information.

M. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

N. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.

O. The Design Consultant's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Design Consultant's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

P. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.

Q. Maintain a complete set of reviewed and stamped shop drawings and product data on site.

R. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

1.10 ELECTRONIC DRAWING FILES

A. AutoCAD

1. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and

handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.11 SUBSTITUTIONS

A. Refer to Bid documents, General and Supplementary Conditions and Division 01 Specification Sections for limitations and restrictions on substitutions in addition to requirements specified in this section.

B. For products, materials, equipment, or systems for which this Division specifically identifies, the Contractor shall use it as the basis for their bid. However, if the Contractor feels a substitute is appropriate for consideration they may submit, as required in these documents prior to bid, for approval by the Design Consultant.

C. Materials, products and equipment described in the Bidding Documents establish a standard of required function, performance, dimension, appearance and quality to be met by the proposed substitution.

D. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

E. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.
    e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

F. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitutions will be considered with receipt of Bids unless the Architect and Design Consultant have received from the Bidder a written request for approval to bid a substitution

at least ten calendar days prior to the date for receipt of Bids and have approved the substitution request.

3. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work of related trades are not permitted.
4. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner, including verbal. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials which meet the performance as stated or implied in the Contract Documents.
5. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.12 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 and General Conditions for Operation and Maintenance Data.

B. Prior to Substantial Completion of the project, furnish to the Architect, for Design Consultant's review, and for the Owner's use, the following Division 28 items:

1. An electronic PDF file containing:

a. A parts list of all equipment installed
b. Equipment datasheets for all equipment installed,
c. Summary of all settings and configurations for each piece of installed equipment
d. Listing of all software and versions install
e. All software licensing information
f. Record Drawings completed in electronic format, updated from submitted Shop Drawings,
g. Manufacturer's service and maintenance data,
h. Warranty certificates
i. Include local contacts complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

2. One physical printed copy of electronic PDF file for the Owner's use, submitted in a three-ring, loose-leaf, hard-back notebook form (binder), divided and tabbed.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Refer to individual sections in this Division for additional requirements.

1.13 APPROVED EQUIVALENTS

A. For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.

1.14 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.

B. Obtain the Owner's or Owner's representative's written acceptance when the specified spare parts for that section are delivered.

1.15 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified in this section.

B. Maintain daily a set of jobsite work prints of the Issued for Construction Drawings, reflecting an accurate dimensional record of deviations between work shown on Drawings and that installed.

1. Record dimensions clearly and accurately to delineate the work as installed; suitably identify locations of all equipment by at least two dimensions to permanent structures.
2. Pay particular attention to those items that require locating for servicing. This includes, but is not limited to, above-ceiling items such as:

a. Cable and conduit routing
b. Pullbox and junction box locations

C. At the completion of the project, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done electronically in [AutoCAD] [Revit] [Adobe PDF] and saved to PDF [and AutoCAD 2007 dwg] format. Mark each sheet "Record Drawing", along with the date, and deliver these Record Drawings to the Architect.

1. PDF versions of the drawings shall have searchable text. "Flattened" PDFs will not be acceptable.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and always, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect and Design Consultant.

D. Be responsible for the safe storage of tools, material and equipment.

1.17 PROJECT CONDITIONS

A. [Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the Site prior to submitting bid to determine the nature and extent of work involved.
2. Schedule Work in the existing building with the Owner.
3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves systems, equipment, raceways, equipment supports or foundations and materials.
4. Remove articles that are not required for the new Work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
5. Relocate and reconnect required facilities that shall be relocated to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
7. Protect adjacent materials indicated to remain. For Work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
8. Locate, identify, and protect <enter applicable descriptions> services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services shall be interrupted, provide temporary services for affected areas.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Use only products listed for their intended use by a NRTL, except products for which no relevant standards exist.

B. Where products are required to be NRTL listed, classified, approved or otherwise each individual item shall bear the NRTL mark by permanent means.

C. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

D. Products and materials shall not contain asbestos, PCB, or any other material, which is considered hazardous by the Department of Environmental Protection or any other authority having jurisdiction.

E. As directed by the Architect, replace materials of less than specified quality and relocate work incorrectly installed.

F. Refer to individual sections for labeling requirements.

G. Install materials and equipment with qualified trade people.

H. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.

I. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.

J. Where factory testing of equipment is required to ascertain performance and attendance by the Owner's representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.

K. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be de-rated with the method of de-rating identified on the submittals.

L. Enclosures for Electronic Safety and Security Infrastructure/equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for Electronic Safety and Security Infrastructure/equipment installed outdoors shall be NEMA type 3R.

M. If products and materials are specified or indicated on the drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of product data submittal.

N. Ship and store all products and materials in a manner that will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain a replacement. Repairs of damaged goods will only be permitted with prior written permission of the Owner/Design Consultant.

O. Part numbers and product codes in these specifications are correct as of the time of writing. Manufacturers may, however, change part numbers and product codes on short notice. In cases where part numbers or product codes differ from technical specifications for a particular product, provide products meeting the minimum technical specifications of the products in the specifications. Notify the Owner/Design Consultant of any product code and or part number changes on the material list submittal.

PART 3 - EXECUTION

3.1 FEES AND PERMITS

A. Secure and Pay all required fees and obtain all required permits related to the Electronic Safety and Security Systems' installation.

B. Pay royalties or fees in connection with the use of patented devices and systems.

3.2 SELECTIVE DEMOLITION

A. Refer to Division 1, Division 2, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. Examine the site to observe existing conditions before submitting a bid.

C. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.

D. Schedule demolition in advance. Schedule work to avoid disruption of normal operations.

E. Materials and Equipment to Be Salvaged:

1. Electronic Safety and Security infrastructure and equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.
2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

F. Reconnect circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.

G. Remove existing conduit and wire back to the Electronic Safety and Security Equipment unless a specific extent of removal is indicated on the Drawings.

H. Electronic Safety and Security Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:

a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 28.

3.3 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.

B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.4 EXISTING SERVICES

A. Existing Electronic Safety and Security Infrastructure services not specifically indicated to be removed or altered shall remain as they presently exist.

B. Where existing services interfere with new construction, alter or reroute such existing equipment to facilitate new construction after obtaining written permission from the Architect. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.

C. Schedule and coordinate with the Owner and with the Architect all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.

D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.

E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.

F. Do not leave services disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Architect.

G. Make repairs and restoration of services before workmen leave the project at the end of the workday in which the interruption takes place.

H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.5 EXAMINATION OF SITE

A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical, electrical, communications, and Electronic Safety and Security installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

3.6 WORK IN EXISTING FACILITIES

A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.

B. Schedule Work in the existing facility with the Owner.

C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves Communications systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.

D. Remove all these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.

E. Channel walls and floors as required to produce the desired result; however, obtain permission from the Architect or Owner for all channeling not specifically noted on the Drawings.

3.7 CLEANING

A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.

C. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.

D. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

E. Touch up and restore damaged finishes to their original condition.

F. All Electronic Safety and Security infrastructure and equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation by the Architect as required.

3.8 DELIVERY, DRAYAGE AND HAULING

A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required and provide proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.

B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, then Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc. at no additional cost to the Owner.

3.9 EQUIPMENT AND MATERIAL PROTECTION

A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.

B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.

C. Provide adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

3.10 CONNECTED PRODUCTS CYBER- SECURITY

A. Software Requirements

1. All firmware in products furnished or provided by the Contractor shall be the latest and most up to date provided by the manufacturer.
2. All equipment requiring users to log on using a password shall be configured with user/site-specific passwords). No system/product default passwords shall be allowed. Coordinate user logins and passwords with Owner prior to system setup.

    a. Passwords shall always be guarded and protected, including during construction phase of the project. Passwords shall not be written on or in any device, enclosure, or room where access could be obtained by others.
    b. Passwords shall be transmitted to owner, and Design Consultants via secure methods, obscuring or encrypting the document to be transmitted. This document shall be secured while stored for submission with the project(s) other submittals, including Shop Drawings and As-Built documentation.

3. Refer to individual sections for additional software requirements.

B. Network and Cybersecurity Requirements

1. For all Electronic Security Systems that have Contractor-provided equipment with an Ethernet/LAN port, Contractor shall coordinate with Owner's IT staff regarding Owner's network and cyber security requirements.
2. The Contractor shall take positive measures to prevent the introduction of cybersecurity threats to the Owner's technology infrastructure and network. These measures shall include but are not limited to:

    a. Coordinate with the manufacturer to ensure newly procured equipment does not have any cybersecurity notices, bulletins, or alerts. Provide a letter to the Design Consultant with the submittal documents for that Specification section confirming there are no active or known cyber threats.
    b. Ensure all installers/technicians installing or configuring equipment are trained on the prevention of introduction of cyber threats to electronics.
    c. The Contractor shall assess any cyber threats / vulnerabilities associated with the specified equipment, prior to procurement/installation. If cyberthreats are discovered, notify the Design Consultant within one Day. Provide the make and model of the associated equipment and the vulnerability.
    d. Follow additional cybersecurity requirements and procedures as directed by the Owner's IT staff.

C. Refer to individual sections for additional Networking and Cybersecurity Requirements.

3.11 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all Electronic Safety and Security infrastructure and equipment furnished and/or installed under this Division.

B. Check and test protective devices for specified and required application and adjust as required.

C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

D. Notify the Architect immediately of all operational failures caused by defective material, labor or both.

E. Refer to individual Sections for additional and specific requirements.

3.12 START-UP OF SYSTEMS

A. Prior to start-up of Electronic Safety and Security systems, check all components and devices, to confirm compliance with manufacturers' recommended installation procedures.

B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

C. Refer to individual Sections for additional and specific requirements.

3.13 OPERATING INSTRUCTIONS

A. Instruct Owner's operating and maintenance personnel in proper starting sequences, operation, shutdown, general maintenance and preventative maintenance procedures, including normal and emergency procedures.

B. Refer to individual Sections for additional and specific requirements.

3.14 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit complete Operation and Maintenance Data.
2. Submit complete Record Drawings.
3. Perform all required training of Owner's personnel.
4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
5. Perform start-up tests of all systems.
6. Remove all temporary facilities from the site.
7. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Architect at least seven (7) days' notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.15 EARLY OCCUPANCY

A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.

1. Refer to individual sections for additional requirements.

B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

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SECTION 280501 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes general construction materials and methods, electronic security equipment coordination, and common Electronic Security Systems installation requirements as follows:

1. Pathways
    a. Conduit
    b. Outlet Boxes
    c. Pull Boxes
2. Grounding and Bonding
3. Firestopping Systems
4. Access Panels
5. Identification

B. *Note* Refer to Division 28 Section "Common Work Results for Fire Alarm Systems" for common work requirements for fire alarm systems. This section specifies the common work requirements of all other Division 28 sections.

1.2 RELATED SECTIONS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Division 28 Section "General Electronic Safety and Security Requirements"

B. Firestopping requirements listed in this section are unique to Division 28 Work. Refer to Division 07 Section "Penetration Firestopping" for general and additional firestopping requirements.

C. Refer to Division 26 for materials and methods for additional requirements for the following:

1. Division 26 Section "Common Work Results for Electrical" for electrical systems coordination.
2. Division 26 Section "Equipment Wiring Systems" for electrical systems coordination.
3. Division 26 Section "Grounding and Bonding for electrical systems" for electrical systems coordination.
4. Division 26 Section "Hangers and Supports for Electrical Systems" for electrical systems coordination.
5. Division 26 Section "Raceways and Boxes for Electrical System" for electrical systems coordination.
6. Division 26 Section "Cable Tray" electrical systems coordination.
7. Division 26 Section "Underfloor Raceways for Electrical Systems" electrical systems coordination.
8. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for electrical systems coordination.

1.3 CODES, STANDARDS, AND GUIDELINES

A. Follow all applicable codes, references, and standards listed in Division 28 Section "General Electronic Safety and Security Requirements".

B. Follow all guidelines listed in Division 28 Section "General Electronic Safety and Security Requirements".

C. Follow the correct revision or printing (UON) of all applicable codes, references, standards, and guidelines.

D. Follow the additional codes, references, standards and guidelines:

1. Follow the additional codes, references, standards and guidelines:

a. For Telecommunications Infrastructure (Category 5e/6/6A and fiber optic cabling) required by this division:

1) ANSI/TIA/EIA-569-C – "Commercial Building Standard for Telecommunications Pathways and Spaces"

b. For Firestopping installed by this division:

1) ASTM E 814 and ANSI/UL1479 – "Fire Tests Through Penetration Firestops"
2) ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
3) ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"

1.4 QUALITY ASSURANCE

A. Install all Work in strict conformance with all manufacturers' requirements and recommendations unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

B. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:

a. FM Research approved in accordance with FM AS 4991.
b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.5 SUBMITTALS

A. Follow the requirements for submittals in Division 28 Section "General Electronic Safety and Security Requirements".

B. The following submittals are due as part of the Pre-Bid Submittal:

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information. Be prepared to submit a sample should the Design Consultant request an evaluation.

C. The following submittals are due at the Pre-Construction Submittal:

1. Contractor Qualifications (for Firestopping Systems): Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
2. Parts List: Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
3. Submit manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:

    a. Cut sheets shall include the following information at a minimum:

        1) Manufacturer's name and logo
        2) Size – including physical and loading dimensions
        3) Maximum span length
        4) Weight supported
        5) Type
        6) Fittings to be used
        7) Method of attachment to structure
        8) Firestop system assembly information for each system to be installed:

            a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:

                i) Firestop manufacturer
                ii) UL system number
                iii) F, T, and L Ratings
                iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

4. Shop Drawings:

    a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.

        1) Each pathway shall be identified by type and size on the drawings.

            a) Example #1: 4" EMT
            b) Example #2: 2" IMC

        2) Each grounding conductor shall be identified by size (and insulation):

            a) Example: #3/0 insulated ground

3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that location.

a) Example #1 – Firestopping Sleeve: EZ-Path Series 22, UL System W-L-3255
b) Example #2 – Backbox in Fire-Rated Wall: Specseal Power Shield, UL System QCSN/CLIV.R14288

4) Each pull box and access panel shall be identified by size and height above finished floor.

a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.

b. Include pathway systems (conduit, cable tray, auxiliary supports, etc.) and other common work on the same shop drawings for Division 28 "Electronic Security Systems".

1) The following submittals are due at the Project Completion Submittal:

a) Record Drawings:

i) Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Division 28 Section "General Electronic Safety and Security Requirements".

b) Keys – Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

1.6 DEFINITIONS

A. Conditionally Approved - the manufacturer has been found reputable by the Design Consultant, but the Design Consultant has not verified that the product offering by manufacturer meets to all specification and project requirements. Contractor shall adhere to submittal review process for final approval on products.

B. Conveniently Accessible – Capable of being reached from the floor or via the use of a 6' to 12' step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.

C. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.

D. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

E. IMC – Intermediate Metal Conduit

F. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

G. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.

H. RMC – Rigid Metal Conduit

I. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

J. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

K. UL – Underwriters Laboratory

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
5. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.

    a. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
    b. Provide offsets, transitions and changes in direction of conduit* as required to maintain proper headroom and pitch on sloping lines. *Refer to Part 3 of this section for stringent conduit bend requirements.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for Division 28 equipment that are behind finished surfaces or otherwise concealed.

D. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS AND MATERIALS

2.1 PATHWAYS FOR ELECTRONIC SECURITY SYSTEMS

A. General

1. Category 6 and fiber cabling and pathways between Equipment Rooms (shared Communications Rooms) and devices are by Division 27.
2. All other cabling serving Electronic Security System devices within the footprint of the building shall meet the following requirements (from device to Equipment Room):

    a. Within concealed conduit from device to overhead ceiling.
    b. For areas above accessible ceilings, supported via J-hooks every 48"-60" back to nearest cable tray or serving Equipment Room. For inaccessible ceilings or ceilings exposed to structure, continue routing cable within conduit.

3. Division 28 "Electronic Security Systems" Contractor is to indicate proposed pathway types/supports and routing on Division 281000 Shop Drawings.

B. Conduit

1. The following manufacturers are Conditionally Approved.

    a. Metal Conduit and Tubing

        1) AFC Cable Systems www.afcweb.com
        2) Anaconda/Anamet www.anacondasealtite.com
        3) AtKore/Allied Tube & Conduit www.atkore.com
        4) Electri-Flex Co. www.electriflex.com
        5) Emerson/O-Z Gedney www.emersonindustrial.com
        6) Sapa/Indalex www.sapagroup.com
        7) Southwire/Alflex www.southwire.com
        8) Wheatland Tube Co. www.wheatland.com
        9) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

    b. Nonmetallic Raceway and Tubing

        1) AFC Cable Systems www.afcweb.com
        2) Anaconda/Anamet www.anacondasealtite.com
        3) AtKore/Allied Tube & Conduit www.atkore.com
        4) Cantex Inc. www.cantexinc.com
        5) CertainTeed www.certainteed.com
        6) Condux www.condux.com
        7) Duraline www.duraline.com
        8) Electri-Flex Co. www.electriflex.com
        9) Superflex Ltd. www.superflex.com
        10) Thomas & Betts/Carlon www.tnb.com

    c. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)]

2. Specifications

    a. Refer to Electrical Division 26 for specific product and material information.

1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

b. Conduits routed within the building as connection to outside devices (exterior to the footprint of the building) shall be rigid metal (RMC) or intermediate metal conduit (IMC) at the point it enters the building, emerges from an exterior wall or ground floor slab to the final Equipment Room termination/transition point.

1) If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated.

c. For interior devices (and devices on the face of exterior walls) Electrical metallic tubing (EMT) with compression connectors shall be used where concealed in walls, above ceiling, and exposed or concealed in equipment rooms.
d. Unless specifically identified on the Security drawings, flexible conduit shall not be used.
e. Conduits shall be dedicated to specific sub-systems (i.e. video cabling shall not be installed in any other sub-system conduit, such as access control, intrusion detection, fire alarm, etc.).
f. Provide conduit as indicated on the Drawings or required by this Specification.

1) Minimum conduit size for all Category 6 cabling shall be: ¾" inch for interior locations and 1" for exterior locations (such as devices at light poles and gates).
2) Provide a polypropylene or monofilament plastic line with not less than 200-lb tensile strength in each conduit.
3) Permanently mark or tag each conduit at the source and inside each pull box, identifying it based on specific subsystem (Access Control, Intrusion Detection, etc) and far-end destination. Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.

C. Outlet Boxes

1. The following manufacturers are Conditionally Approved, unless otherwise noted.

a. Emerson/Appleton
b. Hubbell/RACO
c. Randl Industries
d. Thomas & Betts/Steel City
e. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Specifications

a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
b. For masonry (CMU) walls, backbox shall be 3-1/2 inches deep. Manufacturer shall be:

1) Single gang – RACO 695R, no substitutes

2) Double gang – RACO 696R, no substitutes

c. For stud walls, backbox shall be 2-3/4 inches deep. Manufacturer shall be:

1) Single gang – RACO 560 series, or equivalent from Conditionally approved manufacturer.

d. Telecommunications Boxes for Security – for camera outlets shown on TN drawings:

1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches width by 4-11/16 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension as needed for flush mounting. Depth shall match that of wall gypsum board(s).

a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings), RANDL T-55017 or equivalent with appropriate

2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches width by 4 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension ring as needed for flush mounting. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).

a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.

e. Junction Box – in accessible ceiling space above access-controlled doors

1) Minimum Size 6" x 6" x 4" deep, or as noted on drawings/details, with hinged cover
2) NEMA 1 rating
3) Manufacturer shall be Hoffman A6N64 (or larger) or equivalent from Conditionally approved manufacturer.

f. Pull Boxes - for interior use only, mounted in Conveniently Accessible Locations.

1) Specifications

a) NEMA 1
b) Refer to Execution section for sizing requirements.

2) The following manufacturers are Conditionally Approved.

a) Hoffman
b) NEMA Enclosures
c) Wiegmann
d) Or Equivalent

2.2 GROUNDING AND BONDING

A. Refer to drawings and Division 28 Section "Equipment Room Fittings for Electronic Security" for exact grounding and bonding requirements.

2.3 FIRESTOPPING SYSTEMS

A. General

1. The following manufacturers are Conditionally Approved.

a. 3M
b. Hilti
c. Specified Technologies, Inc

2. Division 28 "Electronic Security Systems" Contractor is to indicate proposed Firestopping locations that correspond to their proposed pathway and cable routing on Division 281000 Shop Drawings.
3. Refer to Architecture / Life Safety plans for locations of fire- and smoke-rated walls.

B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications

a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
c. Shall be a prefabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
d. Allows the installation and removal of cables without the need to remove or add any materials.
e. Used to seal penetrations of cables through fire rated partitions

2. Manufacturer shall be:

a. EZ-Path family of products by Specified Technologies Inc.
b. SpeedSleeve series of products by Hilti
c. Or approved equivalent

C. Firestopping for Backboxes in Fire-Rated Walls

1. Specifications

a. Used to seal backboxes in fire rated partitions.
b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

2. Manufacturer shall be:

a. Specified Technologies Inc., SpecSeal Power Shield
b. Or approved equivalent

D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications

1. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition, and other required firestopping applications not previously addressed in this specification.
2. Specifications:

    a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

3. Manufacturer shall be:

    a. Specified Technologies Inc.
    b. Or approved equivalent

2.4 ACCESS PANELS

A. The following manufacturers are Conditionally Approved.

1.	Activar/JL Industries	www.activarcpg.com
2.	Acudor Products	www.acudor.com
3.	Alfab/Barco	www.alfabinc.com
4.	Elmdor Products	www.elmdorproducts.com
5.	Karp Associates, Inc.	www.karpinc.com
6.	Milcor	www.commercialproductsgroup.com
7.	Nystrom Building Products	www.nystrom.com
8.	Williams Brothers	www.wbdoors.com
9.	Wind-lock	www.wind-lock.com
10.	Or Approved Substitution (submitted and accepted in the "pre-bid" phase)	

B. Specifications:

1. To be utilized for access to a Pull Box that is installed above an inaccessible ceiling (where a Pull Box is required to keep the number of bends in conduit to 180 degrees or less between pull points).
2. Steel Access Panels and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
3. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
4. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:

    a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
    b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
    c. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

5. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
6. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

C. Locking Devices:

1. Where located in a publicly accessible space and are less than 9' AFF, provide a lock.

2. Lock shall be 5-pin or 5-disc type cylinder locks, individually keyed.
3. Provide 2 keys.

D. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.5 FASTENINGS

A. Except in equipment rooms, all exposed securing screws shall be stainless steel, center pin torx security screws. Security Fasteners: A maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Holo-Krome; a Danaher Corporation.
2. Safety Socket Screw Corporation.
3. Tamper-Pruf Screws, Inc.
4. Textron Inc.

2.6 IDENTIFICATION FOR COMMON WORK FOR ELECTRONIC SECURITY SYSTEMS

A. Labels

1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.

a.	Brady	www.bradycorp.com
b.	Brother	www.brother-usa.com
c.	Dymo	www.dymo.com
d.	HellermannTyton	www.hellermanntyton.com
e.	Panduit	www.panduit.com
f.	Or Approved Substitution (submitted and accepted in the "pre-bid" phase)	

2. Specifications:

a. Refer to additional requirements in Part 3 – Execution.
b. Refer to individual sections for additional identification requirements for specific work.

PART 3 - EXECUTION

3.1 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

A. General

1. Refer to Electrical Division 26 for specific installation requirements.

a. Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

2. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
3. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
4. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb. (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
5. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
6. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
7. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
8. Store and keep dry all products in original container in a climate-controlled environment until installation is to occur
9. Install all pathways:

    a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
    b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
    c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
    d. So that the maximum allowable pulling tension is not exceeded.
    e. To meet the requirements of the structure and the requirements of all other Work on the Project
    f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
    g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
    h. Parallel or perpendicular to building lines or column lines.
    i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

10. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall not be used to attach cables to cable supports.
11. Provide adequate pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for. Any deviation from this will not be accepted.

    a. At no point shall cables meet, be supported by, or attach to other trades equipment or supports.
    b. At no point shall cables meet, be supported by, or attach to building structures or supports.

12. Provide appropriately sized sleeves where cables (supported by J-hooks) are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches beyond the partition surface on both sides and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 40% of the cross-sectional area is utilized by the cabling to be installed.

13. Suspended cables shall be installed with at least 3 inches of clear vertical space above the ceiling tiles and support channels (T-bars).
14. Waterproofing

    a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
    b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

15. Cutting and Patching

    a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
    b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
    c. Patch around all openings to match adjacent construction.
    d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
    e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
    f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

16. Mounting Heights

    a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
    b. Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.
    c. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
    d. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

17. Painting

    a. Refer to Division 9 Section "Painting" for painting requirements.
    b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

        1) If painting happens after cabling has been installed, cabling shall be masked off or otherwise protected so that cables are not painted. Paint on cables

degrades the cable over time. PAINTED CABLES SHALL BE REPLACED with no additional cost to the owner.

c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
f. Provide touch-up paint as required by Specification Sections in this Division.

18. Fastenings

a. Fasten equipment to building structure in accordance with the best industry practice.
b. 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 lbs.
c. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1) To Wood: Fasten with lag screws or through bolts.
2) To New Concrete: Bolt to concrete inserts.
3) To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4) To Existing Concrete: Expansion anchor fasteners.
5) To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
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.

d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:

1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

e. For items, which are shown as being ceiling mounted at locations were fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
f. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces.

B. Access to pathways and associated equipment

1. Locate all pull boxes, junction boxes and fire-rated pathway devices to provide easy access for operation, service inspection and maintenance.
2. Provide an access door/panel where equipment or devices are located above inaccessible ceilings. Where access doors/panels are necessary but not shown on the plans, coordinate type and location with Architect and Design Consultant through an RFI.
3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable Distribution

1. For low-voltage cabling (that provides power at 70v or less), refer to section 2.1 above.

D. Conduits

1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
2. Adequate access shall be available where cables enter conduits
3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements (ANSI STD-607 – "Commercial Building Grounding (Earthing) and Bonding Requirements For Telecommunications).
4. Install conduits in the most direct route possible, running parallel to building lines
5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
6. Conduits which enter Telecommunications or Security/Equipment rooms shall extend 3 inches AFF or through the wall.
7. Flexible conduits may only be used where specifically allowed by these contract documents.

    a. Where indicated, flexible conduit sections shall be less than 20 feet in length.

8. No continuous section of a conduit may exceed 100 feet without a Pull Box.
9. No more than (2) 90° bends, or equivalent will be allowed between Pull Boxes.

    a. Each and any offset shall be considered a 90° bend.
    b. A Pull Box is required wherever a reverse bend is installed.

10. The minimum bend radius for conduits is:

    a. (6) times the inside diameter for 2 inches conduits or less.
    b. (10) times the inside diameter for conduits greater than 2 inches.

11. Conduits shall contain no electrical condulets (also known as LBs).
12. Underground Conduit Requirements

    a. Cabling and pathways serving devices exterior to the building, such as emergency phones/towers and security cameras.
    b. Requirements

        1) Refer to applicable details on drawings for illustrative requirements.
        2) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.

            a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide

appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are NOT to be in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.

b) These underground conduits shall stub directly into the serving Communications Room/Equipment Room. If not, extend cabling within the building in IMC or RMC to the serving Equipment Room.

3) Approved conduit types:

a) When routed below slab-on-grade or outside the footprint of the building:

i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.

ii) All vertical and horizontal bends and areas subject to vehicular traffic (loads) such as parking lots and roadways shall be RMC or concrete-encased PVC.

E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.

a. Where possible offset to next stud cavity, with a minimum of 6 inch separation.

2. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
3. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. Pull Boxes

1. Pull Boxes shall be placed in Conveniently Accessible locations.
2. Coordinate the location and installation of all Pull Boxes to ensure adequate access is provided.
3. Pull Boxes above an accessible ceiling shall:

a. Be aligned directly over the ceiling grid to allow access
b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles

4. No directional changes shall be allowed in Pull Boxes. Conduit shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size Pull Boxes according to the following chart:

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit
1"	4"	4"	2-1/8"	N/A
1-1/4"	4"	4"	2-1/8"	N/A
1-1/2"	4"	4"	2-1/8"	N/A
2"	4"	4"	2-1/8"	N/A
2-1/2"	4"	4"	2-1/8"	N/A
3"	4"	4"	2-1/8"	N/A
4"	4"	4"	2-1/8"	N/A

3.2 LABELING

A. Labeling Installation

1. Labels are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on or for:

a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.
b. All pathways (e.g., conduit etc.) installed under this work.

1) Label all conduit with "SECURITY". Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.

a) For wall stub-up locations, label overhead only.
b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.

i) Example – "Security to Panel 1 in Equipment Room 127".

c) For conduits that stub directly up or into an Equipment Room, label both ends of conduit.

i) Example: under slab/ground conduit from Equipment Room 127 to Camera #13 attached to an exterior light pole shall be labeled as follows:

(1) Conduit stub-up location in Equipment Room 127 – "Security to Camera #13".
(2) In the light pole/junction box, immediately adjacent to serving conduit – "Security to Equipment Room 127".

2) All pullboxes and junction boxes for Security shall be labeled "SECURITY PULLBOX" on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.

a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – i.e. "To Security Camera #17 in Room 114".

c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
d. Refer to individual Division 28 sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

1. Provide fire resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations, including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.

    a. Assume all floors are fire-rated, unless otherwise noted.
    b. Also install fire stops at any other locations indicated in the Specifications or Drawings.

3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:

    a. Fire stop Manufacturer
    b. Installer and company
    c. Date installed
    d. UL system number with all relevant ratings indicated

4. Include labels in each Equipment Room in which one or more fire-rated walls is installed. Provide a 2" block letter stencil label on the inside of the room to indicate rating for each barrier.
5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.

C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.

D. Fire-Rated Pathway Device

1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION 280501

SECTION 281010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. As part of a complete and functioning Electronic Security System and associated infrastructure, provide conductors and cables of appropriate type. This section includes:

1. Low-voltage Control and Power Cables
2. Coaxial Cabling

B. Conductor and cable requirements are unique to each manufacturer equipment / device. Unless otherwise noted, exact conductor and cable types are to be coordinated by the ESC to meet the requirements of the Electronic Security manufacturer

1.2 RELATED SECTIONS

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

B. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".

C. Conductors and cables as specified in this section shall be supported and installed into pathways, backboxes, firestopping, and other general/common work per Division 28 Section "Common Work Results for Electronic Security Systems".

D. Refer to Division 27 Specifications for all Category 6 and Fiber Optic Cable requirements.

E. Refer to Division 28 Section "Equipment Room Fittings for Electronic Security" for grounding and bonding requirements.

F. Refer to individual Electronic Security System sections for additional conductor and cabling requirements.

1.3 SUBMITTALS

A. Follow the requirements for submittals in Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".

B. The following additional requirements at due at the following submittal phases:

1. Pre-Construction Submittal

a. Cut sheets shall contain the following information for each of the cables specified.

1) Manufacturer's name and logo
2) Cable outside diameter
3) Number of conductors/strands in each cable and binder group

4) Gauge or strand thickness
5) Cable jacket material and rating (i.e. Plenum, Riser, wet-rated, etc.)
6) Maximum pulling tension
7) Jacket/Sheath color
8) Individual conductor or strand insulation colors (if applicable)
9) Minimum bend radius

a) During installation and post installation, if it differs.

b. Shop Drawings

1) Cable types required by this Section are to be identified on Shop Drawings for the following Electronic Security sub-systems: (separate 281010 Shop Drawings for this section are not needed)

a) Access Control
b) Video Intercom
c) Video Surveillance

2) On the Shop Drawings for those Electronic Security sub-systems, show the proposed routing of all conductors and cables and the means of support:

a) Cable Tray
b) Conduit (solid line)
c) J-hooks every 48"-60" (dashed line), if allowed by Contract Documents

3) On the Shop Drawings for those Electronic Security sub-systems, include details showing the proposed termination and labeling (ID) scheme at each device and panel for each conductor/cable.

2. Preliminary Project Completion Submittal

a. Follow all requirements as specified in Division 28 Section "Electronic Security Systems".
b. Update the approved shop drawings with any changes in cable routing and submit as part of Preliminary Record Drawings per Division 28 Section "Electronic Security Systems".
c. Test Results

1) Include conductor/strand test as part of the Functional Test Reports for each Electronic Security sub-system.

d. Cable ID spreadsheet, saved in PDF and Microsoft Excel file formats, which shall include the following for each cable installed under this section:

1) Electronic Security Sub-System
2) Device Type
3) Device Identifier
4) Device Room Number (if not part of Device Identifier)
5) Headend Panel Identifier
6) Headend Panel Room Number (if not part of Headend Panel Identifier)
7) Cable Identifier

Sub-System	Device Type/ID	Device Rm	Headend ID	Headend Rm	Cable ID

Access Control	Card Reader 01	Vestibule 101 ACP-01	IDF 114	AC-CR01-ACP01

3. Final Project Completion Submittal

    a. Follow all requirements as specified in Division 28 Section "Electronic Security Systems".
    b. Incorporate any changes from punch list items.
    c. Include updated Cable ID spreadsheet.

1.4 DEFINITIONS

A. Damp Location – as defined by the NEC, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.

B. Point of Entrance (Building Entrance) – as defined by the NEC, the point within a building where the security cabling routed through a Wet Location emerges from an external wall, a concrete floor slab, or IMC/RMC.

C. Qualified Electrician – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved; regarding this project, a Qualified Electrician is also licensed in the jurisdiction of the project to install electrical equipment (i.e. Journeyman or Master Electrician License).

D. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

A. Conductors and cables shall meet the following the requirements:

1. UL Listed and Approved for the intended application

    a. Where areas above accessible ceilings are serving as plenum (air) return, and conductors/cabling is not installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Plenum (CMP) rated.
    b. Where conductors/cabling are installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Riser (CMR), or Plenum rated.
    c. Where conductors are/cabling are routed through a Wet Location,

2. Cable type and conductor size/quantity shall be as recommended or required by the device/equipment manufacturer. Where the Contract Documents differ from manufacturer recommendations or requirements, notify the Architect requesting clarification.
3. Conductor sizes, if shown, are minimum. Where approved by the Design Consultant and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option

to utilize stock sizes, provided raceway sizes are increased to correspond with fill ratio requirements defined the NEC.

4. Conductors and cables shall be shielded.

    a. Submit RFI for any manufacturer equipment that recommends non-shielded cable.

B. The following Manufacturers are conditionally approved:

1. Belden
2. Draka
3. General Cable
4. Tappan
5. West Penn Wire

2.2 LOW-VOLTAGE CONTROL AND POWER CABLES

A. For 10 AWG through 24 AWG, and single conductors through 24-pair applications, as needed per project.

B. General requirements:

1. Shielded (overall shield)
2. Stranded and insulated conductors
3. PVC jacket
4. Size conductors per manufacturer recommendations and power/voltage drop based on installed cable length.

C. Manufacturer shall be:

1. Submit product cutsheets concurrently with Shop Drawings, identifying cable type, manufacturer, and part number on the Riser Diagram.

    a. Call out non-plenum (Riser-rated and Wet-rated) cables (where specifically allowed)

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

A. Pre-Installation

1. Following the Notice to Proceed, the ESC's Quality Control Specialist or Project Manager (as defined in Division 28 section "Electronic Security Systems") shall coordinate with the Contractor or Sub-Contractor responsible for Division 28 "Common Work Results for Electronic Security Systems" (i.e. the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:

    a. Conduit routing
    b. Conduit type for Building Entrance(s) – (see requirements below)

2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:

a. Division 28 "Common Work Results for Electronic Security"
b. Division 28 "Electronic Security Systems"

3. After conduits/pathways are installed, but prior to cable installation, ESC's Quality Control Specialist and Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:

a. Conduit sizes and quantities matches Construction Documents and Project requirements
b. Minimum bend radius
c. Quantity of bends in conduit between pullboxes (180 degree change in direction, maximum)
d. Building Entrance conduits are of appropriate type
e. Any visible indication of improper or incomplete installation that may damage cable as it is installed.

B. General Requirements

1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.

a. Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the Equipment Room, cables may be consolidated and routed in overhead conduit and conduit sleeves.
b. Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Division 28 Section "Common Work Results for Electronic Security"; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.

2. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor in backbox at each device location.
3. A Qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
4. All cables shall be plenum-rated unless noted otherwise.
5. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

a. Except when supported by ladder racking within each Telecommunications room, UON.

6. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb. tensile strength. Leave at least 12 inches of slack at each end of pull cord.
7. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
8. Comply with all referenced standards and guidelines.
9. Cables shall be masked, covered, or otherwise protected from being painted or meeting any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.

10. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:
11. A minimum of 3 feet (1 meter) in length, unless noted otherwise.
12. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
13. Install all cables and conductors in compliance with the requirements of Article 725 of the NEC, paying special attention to the following:

    a. Cables shall be installed in a neat and workmanlike manner.
    b. Separation requirements dependent upon installation location and proximity to other circuits.

C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Wet Locations or as required by these construction documents. (i.e., all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)

1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Equipment Room in accordance with the NEC; or a suitably-sized junction box shall be provided in an accessible location within 50' of where the outdoor cabling/conduit enters the building enters the building to allow the cable to transition from wet-rated to plenum-rated.

    a. Indicate this location on pre-construction shop drawings and final Record Drawings.

3. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 28 Section "Equipment Room Fittings for Electronic Security".

3.2 CABLE IDENTIFICATION

A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings or as described in Division 28 Section "Electronic Security Systems". Where the drawings and specifications are silent, submit RFI through appropriate channels requesting labeling scheme.

1. Shop drawings shall include floor plan and/or riser diagram that indicates proposed cable/device identification for each device.

B. Cables shall be labeled within 6" at each end.

C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

1. Brady, IDXPERT
2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or equivalent

3.3 GENERAL CABLE TESTING

A. Pre-installation testing:

1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
2. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

B. Post-installation testing (but prior to termination to devices/panels):

1. Conduct cable continuity testing upon completion of installation on each conductor.
2. Remove all defective cables from pathway systems. Do not abandon cables in place.

3.4 CABLE TERMINATIONS

A. Cable connections to device and security panel shall be soldered and heat-shrunk from jacket to jacket. Exposed conductors, even within an enclosure or backbox, are not allowed.

3.5 ACCEPTANCE

A. The ESC's Quality Control Specialist shall conduct an inspection after conductors and cabling have been installed to ensure compliance with the Construction Documents and project requirements.

B. Functional tests of the conductors and cables connected to equipment will be conducted by the ESC as part of Test Reports as specified in Division 28 "Electronic Security Systems" and individual Electronic Security sub-system Sections.

END OF SECTION 281010

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SECTION 284600 - FIRE DETECTION AND ALARM

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

1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
2. Division 26 Section "Common Work Results for Electrical," for materials and methods for coordination, sleeves and common installation requirements.

1.2 DESCRIPTION OF WORK

A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.

B. Division 28 of the Specifications and Drawings numbered with prefixes FAgenerally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the following statement only if fire alarm drawings are being submitted directly to the Authority Having Jurisdiction (AHJ) for approval prior to shop drawings being generated. Add the state the project is located in and revise the name of the AHJ accordingly.

D. The scope of work in this section includes:

1. Fire alarm control unit
2. Manual fire alarm pull stations
3. System smoke detectors
4. Carbon monoxide detectors
5. Notification appliances
6. Air handling unit shutdown
7. Battery stand-by power
8. Multi-channel one-way voice notification system

1.3 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.4 APPLICABLE CODES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.

1. NFPA 70, "National Electrical Code", 2017 Edition.NFPA 72, "National Fire Alarm and Signaling Code", 2016 Edition.
3. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
4. International Building Code (IBC) 2018 Edition with local amendments.
5. International Fire Code (IFC) 2018 Edition with local amendments.

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.5 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
6. FACP: Fire Alarm Control Panel.
7. NICET: National Institute for Certification in Engineering Technologies.
8. AHJ: The local code and/or inspection agency (authority) having jurisdiction over the work.
9. Engineer: Where referenced in this division, "Engineer" is the Engineer of record and the Design Professional for the work under this division and is a consultant to, and an authorized representative of, the Architect, as defined in the general and/or supplementary conditions. When used in this division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to the "Architect"

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.6 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.

C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in

establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.

F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:

1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.
2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.
3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.
4. Conduit shall be by Division 26 "Common Work Results for Electrical".

G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.7 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.

B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.

C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.

D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.

E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.

F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless the Contractor has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.

J. Shop Drawings:

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Shop drawings shall be prepared by a NICET Level II or higher certified technician. Submit copies of the certification for the designer with submittal.
3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.
4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).
5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.
6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.

7. Include voltage drop calculations for notification-appliance circuits.
8. Include battery-size calculations.
9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than 3/32" = 1'-0".
10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.

K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.

L. Qualification Data: Submit copies of the certification for the Installer.

M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for Substitutions.

B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.

D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.

B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:

1. Typewritten Index.
2. Qualifications. Provide designer and installer qualification.
3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
5. Product Data: Provide product cutsheets for all equipment utilized and installed.
6. Riser diagram.
7. Device addresses.
8. Record copy of site-specific software.
9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

    a. Equipment tested.
    b. Frequency of testing of installed components.
    c. Frequency of inspection of installed components.
    d. Requirements and recommendations related to results of maintenance.
    e. Manufacturer's user training manuals.

10. Manufacturer's required maintenance related to system warranty requirements.
11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.
12. Guarantee. Copy of all guarantees and warranties issued.
13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.

B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.

C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.

D. Refer to Division 1 and General Conditions for Record Drawings

E. At the completion of the project, the Contractor shall obtain at their expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Engineer.

1.13 SPARE PARTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide 10% of the total or a minimum of one (1) manual pull station.
2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
3. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.

4. LSN/LSW: Provide 5% of the total or a minimum of two (2) of each speaker type. Combination speaker/strobe units matching the units installed are acceptable.
5. LSHS: Provide 5% of the total or a minimum of two (2) of each horn type. Combination horns/strobe units matching the units installed are acceptable.
6. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.

B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.

C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.

D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

A. Refer to Division 1 and General Conditions for Guarantees and Warranties.

B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.

C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.

D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.

E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

1.16 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting a bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Fire Alarm Contractor shall perform the demolition which involves fire alarm system equipment and materials.
4. Fire Alarm Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall be removed from the premises and disposed of in accordance with applicable federal, state and local regulations.
5. Fire Alarm Contractor shall relocate and reconnect fire alarm equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. General Contractor shall install finish material.
6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
7. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
8. Locate, identify, and protect Fire alarm services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

C. Interruption of Existing Fire alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire watch service according to local Fire Department requirements:

1. Notify Construction Managerno fewer than seven days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Construction Manager's written permission.

D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.17 SEQUENCING AND SCHEDULING

A. Existing Fire alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it

is accepted. Remove labels from new equipment when put into service, and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire alarm system, remove all unused fire alarm equipment, wiring and installation materials not necessary for system functionality or spare parts.

PART 2 - PRODUCTS AND MATERIALS

2.1 SYSTEM DESCRIPTION

A. LSN/LSW: Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice/strobe evacuation.

B. LSHS: Noncoded, UL-listed addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. All components provided shall be listed for use with the selected system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.2 MANUFACTURER

A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:

1. Notifier

2.3 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual pull stations.
2. Smoke detectors.
3. Carbon monoxide detectors.

B. Fire alarm signal shall initiate the following actions:

1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).

    a. A pulsing alarm tone shall occur within the control panel until acknowledged.
    b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm

received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.

2. Transmit an alarm signal to the alarm supervising station.
3. Audible notification appliances shall sound until silenced by the alarm silence switch at the control panel.
4. All visible alarm notification appliances shall display a continuous synchronized pattern until reset by the Alarm Reset Switch.
5. Record events in the system memory.
6. Activate voice/alarm communication system.
7. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Duct-smoke detectors
2. User disabling of zones or individual devices.
3. Loss of communication with any panel on the network.

D. System Supervisory Signal Actions:

1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).

a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.

2. Record events in the system memory.
3. After a time delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
4. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.
5. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire alarm control unit.
5. Ground or a single break in internal circuits of fire alarm control unit.
6. Abnormal ac voltage at fire alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire alarm control unit or annunciator.
10. Voice signal amplifier failure.

F. System Trouble Signal Actions:

1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).

    a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
    b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.

2. Record events in the system memory.
3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.

2.4 FIRE ALARM SYSTEM CONTROL UNIT

A. The fire alarm control unit is existing to be modified. Where guidance is needed refer to the following:

General Requirements for Fire alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
    f. The control unit shall have dedicated alarm, supervisory and trouble LED's and dedicated alarm, supervisory and trouble acknowledge, and alarm silence switches.
    g. Lamp Test: Manual lamp test function causes each LED to function at fire alarm control panel.
    h. Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.
    i. The FACP shall be provided with surge protection.

    j. Install in a flush mounted enclosure.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands. and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. The location of the dedicated branch circuit disconnecting means shall be permanently identified at the control unit.
2. The circuit disconnecting means shall have a red marking and be provided with a breaker lock or other approved method to avoid accidental operation.
3. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

D. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead acid.
2. LSN/LSW: The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 15 minutes.
3. LSHS: The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 5 minutes.

E. System Supervision: Automatically detects and reports open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification appliance circuits. Alarm, supervisory and trouble signals shall be monitored by the supervising station over a Digital Alarm Communicator Transmitter (DACT), or other approved method.

2.5 EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEMS (EVACS):

A. The system shall incorporate one-way emergency voice communication via specified speakers. A central audible module shall provide for the necessary alarm message/tone generation, main and remote microphone connections and mixers/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure (main microphone trouble, tone trouble, etc.)

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire alarm control unit.

2. Hand held push to talk, noise canceling microphone in recessed protective panel mounted enclosure; 5 feet coiled cable; and LED to indicate the microphone push to talk has been pressed.
3. Audible power amplifiers shall be self filtered; contain 24 volt power supply, transformer and amplifier monitor circuits; Amplifier shall operate all system speakers plus twenty-five (25) percent spare capacity.

4. Digitized voice messages are required to notify building occupants during alarm conditions. Message player shall not rely on tape or mechanical means of transmitting the voice message. A standard evacuation message shall be provided; however, the system shall be capable of transmitting a custom message of up to five (5) minutes long.
5. Alarm sequence shall consist of a temporal (3) alarm tone for a maximum of 15 seconds followed by an automatic pre-selected message. At the end of the message the tone shall resume. This sequence shall continue until the fire alarm control panel has been silenced. Manual voice paging shall be available via panel switches to page individual floors or groups of floors. Each floor shall be an individual audible zone and have a corresponding audible switch.

2.6 INITIATING DEVICES

A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
2. Station Reset: Key or wrench operated switch.

3. Indoor Protective Shield: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.

1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.

1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.

5. Provide remote alarm LEDs and remote test stations as shown on the plans.

6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.
2. Provide strobe synchronization as required per NFPA 72.
3. Wall mounted notification appliances shall be manufacturer standard white finish.
4. Ceiling mounted notification appliances shall be manufacturer standard white finish.

B. Alarm Horns: Comply with UL 464. Electric vibrating polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated ¼ to 2 watts and produce 79 to 88 dB at 10 feet.

D. Special Application Speakers (Wall Mount):

1. Atlas/Soundolier voice control loudspeaker, model number APF-15TU. Model shall be a double re-entrant type with 15 watts RMS audible power rating compression driver producing a UL-rated sound pressure level of 102 dB measured at 15 watts at 10 feet, within a frequency range of 400 Hz to 4 kHz. Loudspeaker assembly shall be furnished with mounting bracket allowing adjustment on either a vertical or horizontal plane with a single locking pin and including provisions for mounting, banding or strapping. Wiring terminals for amplifier output shall be fully enclosed and vandal–resistant adapter cover shall provide connection facilities for cable or conduit. Unit shall be finished in red baked epoxy.
2. Wheelock ET 1010 Speaker - vandal resistant loud speaker. Speaker includes both 25 and 70 volt VRMS inputs with field selectable power taps from 1/8 to 8 watts with listed sound output up to 96 dB for speakers. All models shall have provisions for standard NAC supervision and IN/OUT field wiring using terminals that accept #12 to #18 AWG wiring.

E. Special Application Speakers (Ceiling Mounted):

1. Quam UL22/25 or UL22/70 – Lay-in Speaker: UL Listed, shallow depth, lightweight, tile replacement, fire-protective signaling device with an 8C10PAFR - 8" O.D. loudspeaker, 10 oz. magnet, fire retardant components and a 4W-70V rotary select transformer. Integral enclosure is 1,412 CID molded fiber. Grille is perforated steel with four (4) seismic tie-off points in a white powder coat finish. Line supervision capacitor is included. No assembly required.
2. Atlas/Soundolier, model number #UHT, UL listed to Standard 1480, 8-inch cone, multi-tapped design with output power of 1/2, 1, 2, 5 watt and 10 watt with either 25 or 70.7

VRMS input. Semi-flush ceiling mounted; #U51-8 standard round grille with #U95-8 enclosure (required for UL listing). Speaker output shall exceed 80 dBa at 10 feet and not exceed 120 dBa at the minimum hearing distance from the device. The speakers shall have multiple taps and shall utilize the 2-watt tap on the Atlas/Soundolier 10 watt speaker.

2.8 AUXILIARY DEVICES

A. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.

B. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

2.9 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for smoke detectors, notification appliances, or other device requiring protection as indicated on the plans.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Factory finished to match the color of the protected appliance or device.

2.10 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.

B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.

C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.

D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.

E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.

F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

G. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

H. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

I. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.

1. Initiating Device Circuits: Class B

a. Pathway Survivability: Match existing circuits.

2. Notification Appliance Circuits: Class B.

b. Pathway Survivability: Match existing circuits.

3. Signaling Line Circuits: Class B

c. Pathway Survivability: Match existing circuits.

4. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.

2.11 ACCESS TO EQUIPMENT

A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper materials for type of construction where installed.
4. The exact location of all access doors shall be verified with the Architect prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.

9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

    a. Arrow United Industries.
    b. Bar-Co., Inc.
    c. J.L Industries.
    d. Karp Associates, Inc.
    e. Milcor Div. Inryco, Inc.
    f. Nystrom Building Products
    g. Wade
    h. Zurn

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install, program and test all new equipment identified in this contract and revise existing equipment as noted in accordance with the applicable codes, standards, and manufacturer's instructions.

B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.

C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.2 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

    1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

    1. Devices placed in service before all other trades have completed cleanup shall be replaced.

2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel.
2. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

D. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.

E. Smoke Detectors: Provide detectors as shown on drawings.

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
2. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
3. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
4. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
5. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.

F. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.
2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.

G. Carbon Monoxide Detections: Provide detectors as shown on drawings. The installation shall comply with manufacturer's recommendations and NFPA 720, "Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment," as referenced by NFPA 72.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, or valve-tamper switch that is not readily visible from normal viewing position.

I. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.

J. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.

K. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.

L. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.

M. All notification appliance speakers shall be tapped at ½ watt unless noted otherwise on drawings. In rooms less than 100 sq ft, speakers are permitted to be tapped at ¼ watt.

3.4 PATHWAYS

A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.

1. Exposed pathways shall be installed in conduit, routed parallel to structural elements, routed above bottom of structure, routed to minimize visibility, and painted to match surrounding finishes where applicable.

A. Minimum allowable conduit size shall be ¾ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

B. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.

C. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.

D. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.

E. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.

F. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.5 CONNECTIONS

A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.

3.6 SINSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).

C. The location of end-of-line resistors shall be identified with a label indicating "EOL."

3.8 GROUNDING

A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.

   1. Smoke detectors shall be tested with products of combustion.

B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.

C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:

1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

    a. Test audible appliances for the public operating mode according to manufacturer's written instructions.
    b. Test visible appliances for the public operating mode according to manufacturer's written instructions.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire alarm system will be considered defective if it does not pass tests and inspections.

3.10 DEMONSTRATION

A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.

B. Demonstrate normal and abnormal modes of operation, and required responses to each.

END OF SECTION 284600

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Project Storm Water Pollution Prevention Plan and Site Disturbance Documents

1.2 SUMMARY

A. Section Includes:
1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:
1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Division 01 Section "Execution" for field engineering and surveying.
3. Division 02 Section "Structure Demolition" for demolition site improvements.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. 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.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally 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 nonsoil materials.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

C. Utility Locator Service: Notify One Call for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

H. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches above the ground. Tree Masses should be protected with tree protection fencing.

C. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. 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 erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Contractor is responsible for verifying the accuracy of existing private utilities information provide by the District and illustrated on plans with the actual site conditions. Either the contractor or a qualified subcontractor under the direction of the Owner of Architect will repair any damage to utility infrastructure. Costs of these repairs will be the responsibility of the Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting 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 Construction Manager and Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Utilities' written permission.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
   3. Use only hand methods for grubbing within protection zones.
   4. Chip removed tree branches and dispose 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.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Boring Logs completed by CFS Engineers.

C. Project Geotechnical Report completed by CFS Engineers (Project 20-1075) dated June 12, 2020 and any addendums issued to that report. *If specifications differ from recommendations in the Geotechnical Report, Geotechnical Report shall govern*.

1.2 SUMMARY

A. Section Includes:
1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:
1. Division 01 Section "Construction Progress Documentation" for recording preexcavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
4. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
5. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
6. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
7. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
8. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
9. Division 33 Section "Subdrainage" for drainage of foundations, slabs-on-grade, walls, and landscaped areas.

1.3 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. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Suitable soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that reduces upward capillary flow of pore water.

F. 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 Architect. 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 feet (3 m) in width and more than 30 feet (9 m) in length.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to establish design grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed below the building slab and drainage course between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
   1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify "One Call" for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Section "Site Clearing," are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient suitable materials are not available from excavations.

B. Suitable Soils: Soil Classification Groups CL, CH, ML, GW, GP, GC, GM, SM, SW, SC, and SP according to ASTM D 2487, 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 (organic content less than 5%). Refer to Geotechnical Report for additional information.
1. Imported fill materials for building and paving areas consists of low swell potential cohesive soils:
   a. Liquid limit: less than 45% when determined in accordance with wet preparation procedures outlined in ASTM D 4318.
   b. Plasticity index: less than 25.
2. Structural fill placed under the floor slab and drainage course shall consist of low volume change (LVC) material which consists of
   a. Imported Fill meeting the requirements of Section 2.1 B1., capped with 6” crushed stone as noted in section 2.1D to create working platform or
   b. Crushed Stone as noted in section 2.1 D.

   Refer to the project Geotechnical report for required thickness of LVC under the building slab and drainage course.
3. Structural fill placed under pavement subgrades shall consist of low volume change (LVC) material, which consists of

a. Imported Fill meeting the requirements of Section 2.1 B1. Capped with Crushed Stone.
b. Crushed Stone as noted in sections 2.1 D.
c. Crushed Stone constructed over geogrid for construction laydown and staging area. Section as outlined in the project geotechnical report or plans if applicable

Refer to project Geotechnical report for required thickness of LVC.

4. Imported Fill Materials for landscape and turf areas shall consist of approved materials as defined as suitable soils as noted in Section 2.1B
5. 9“ of Subgrade under vehicular paved areas shall be stabilized with 5% by weight Portland Type 1/2 Cement as recommended in the project geotechnical report.

C. Unsuitable Soils: Soil Classification Groups ML, MH, OL, OH, and PT according to ASTM D 2487, or a combination of these groups.
1. Unsuitable soils also include suitable soils at the moisture condition specified in section 3.13.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; meeting the gradation requirements of a MoDOT Type ‘5’ aggregate or KDOT AB-3 aggregate .

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; meeting the gradation requirements of a MoDOT Type ‘5’ aggregate or KDOT AB-3 aggregate.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; as indicated on plans and defined in applicable sections of the APWA Specifications.

G. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed limestone gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

H. Sand: ASTM C 33; fine aggregate

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) 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 (750 mm) 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 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 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. Refer to the project geotechnical plan for boring maps and plans for additional information.
   1. If excavated materials intended for fill and backfill include unsuitable soil materials and rock, replace with suitable soil materials.

3.4 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. Overexcavation of Building pad shall be completed as noted in the foundations section of the project geotechnical report.
   2. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   3. 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.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
   1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
1. Clearance: As indicated.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course for rigid pipe; 6 inches for flexible pipe. Hand-excavate deeper for bells of pipe.
1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:
1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.7 SUBGRADE INSPECTION

A. Notify Owner’s testing agency when excavations have reached required subgrade.

B. If Owner’s testing agency determines that unsuitable soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a loaded tandem-axle dump truck or similar vehicle 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, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner’s testing agency, and replace with compacted backfill or fill as directed.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings with suitable soil fill compacted per sections 3.13 and 3.14.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Owner's testing agency.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 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, 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.

3.11 UTILITY TRENCH BACKFILL

A. Refer APWA Specifications, Section 2100 as adopted by the local governing authority for Site Utility Trench Backfill Requirements.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Aggregate or Controlled Low-Strength Material: As noted in the APWA specifications.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 5 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
1. Under grass and planted areas, use suitable soil material.
2. Under walks and pavements, use suitable soil material or gravel base/subbase course.
3. Under steps and ramps, use suitable soil material, gravel base/subbase course material.
4. Under building slabs, use suitable soil material or gravel base/subbase course, granular drainage “leveling” course material.
5. Foundations shall bear on suitable soils.
6. Footings shall bear on suitable soils.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisture condition subgrade and each subsequent fill or backfill soil layer before compaction to a range of)% to +4% of optimum for soils with a liquid limit of greater than 40 and +/-3% of optimum for soils with a liquid limit of less than 40 of the maximum dry density as determined by ASTM D 698. Refer to the project geotechnical report.
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 suitable soil material that do not meet the specified moisture range.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Moisture Condition soils as required. Moisture contents shall be within 0 to +4% of optimum for soils with a liquid limit of greater than 40 and +/-3% of optimum for soils with a liquid limit less than 40.

D. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under structures and building slabs, building pad shall be undercut to a level to allow the minimum thickness of lower plasticity structural fill as described in project geotechnical report. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under pavement undercut to a level to allow the minimum thickness of lower plasticity structural fill as described in project geotechnical report. Cement Stabilize, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
4. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
5. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.15 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 Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

3.16 SUBBASE AND BASE COURSES UNDER BUILDING SLABS, PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under building slabs, pavements and walks as follows:
1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase course and base course to required crown elevations and cross-slope grades.
3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections. Contractor is responsible to schedule tests in a timely manner and at the rate specified in the sections below.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. 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 materials to depth required; recompact and retest until specified compaction is obtained.

3.18 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 Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus suitable soil and waste materials, including unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Kansas City Metropolitan Chapter of APWA Specifications Section 2200 adopted February 15, 2017 as amended by the local Governing Authority apply to the Construction of this project.

1.2 SUMMARY

A. Related Sections:

1. Division 02 Section "Structure Demolition" for demolition, removal, and recycling of existing asphalt pavements, and for geotextiles that are not embedded within courses of asphalt paving.
2. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.
2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
3. Job-Mix Designs: For each job mix proposed for the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the Kansas or Missouri Departments of Transportation.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the latest specifications The Kansas City Metropolitan Chapter of APWA Specifications as amended by the local governing authority for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Refer to applicable weather limitations as defined in Construction sections applicable to type of work to be performed.

PART 2 - PRODUCTS

2.1 AGGREGATES, ASPHALT MATERIALS, AUXILIARY MATERIALS

A. General: Use materials and gradations that have performed satisfactorily in previous installations and meet the requirements set forth in the local adopted specifications.

2.2 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction:
   1. Base Course: Refer to Plans for mix Design
   2. Surface Course: Refer to Plans for mix Design (Virgin Mix Required for Surface Course)

B. Emulsified-Asphalt Slurry: If not specified on plans, ASTM D 3910, Type 1 or Type 2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements 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, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
   2. Proof roll with a loaded tandem-axle dump truck or equivalent vehicle.
   3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner’s testing agency, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-footstraightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Asphalt Curbs and Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.

3.3 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Reference APWA Specification Section 2206.6 and plans for requirements

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.5 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Kansas City Metropolitan Chapter of APWA Specifications Section 2208, 2209 and 2301 adopted February 15, 2017 or the most Current Addition as amended by the local Governing Authority apply to the Construction of this project.

1.2 SUMMARY

A. Section Includes:
1. Concrete Paving.
2. Curbs.
3. Walks.

B. Related Sections:
1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the latest specifications The Kansas City Metropolitan Chapter of APWA Specifications as amended by the local governing authority for asphalt paving work.
1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

B. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

C. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.5 PROJECT CONDITIONS

Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

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

2.2 REINFOCEMENT

A. As noted in APWA Specification Section 2208.3B

2.3 CONCRETE MATERIALS

A. As noted in APWA Specification Section 2208.3A

2.4 CURING MATERIALS

A. As noted in APWA Section 2208.3H

B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

C. Water: Potable.

2.5 RELATED MATERIALS

A. Joint Fillers: As noted in APWA Specification Section 2208.3C.

2.6 WHEEL STOPS

A. Wheel Stops: As detailed on plans.
   1. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.

2.7 CONCRETE MIXTURES

A. Refer to plans for concrete mix design as applicable. If no direct reference to the concrete specifications is included on the plans, concrete shall meet the requirement of the Kansas City Metro Materials Board (KCMMB).

PART 3 - EXECUTION

3.1 CONSTRUCTION OF PORTLAND CEMENT CONCRETE PAVING AND CURBING

A. As noted in APWA Specification Section 2208.4, 2208.5 and 2209.4. with the following additions:
   1. All sidewalk joints shall be hand tooled unless specified otherwise on Architectural Plans.

3.2 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
   1. Elevation: 3/4 inch.
   2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch
   3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 inch.
   4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
   5. Lateral Alignment and Spacing of Dowels: 1 inch.
   6. Vertical Alignment of Dowels: 1/4 inch.
   7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
   8. Joint Spacing: 3 inches.
   9. Contraction Joint Depth: Plus 1/4 inch, no minus.
   10. Joint Width: Plus 1/8 inch, no minus.

3.3 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to 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, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.5 REPAIRS AND PROTECTION

A. Repair defects in concrete in accordance with APWA Specification Section 2208.6.

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 not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

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. The Kansas City Metropolitan Chapter of APWA, Specifications Section 2200, Latest Edition.

1.2 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.

B. Related Sections:
   1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
   2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
   3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

1.5 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

B. Single-Component, Elastomeric Joint Sealant for Concrete: ASTM C920, Class as noted on plans.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.
   1. Joint Location:
      a. Expansion and isolation joints in cast-in-place concrete pavement.
      b. Expansion and isolation joints in cast-in-place concrete slabs and walks.
   2. Silicone Joint Sealant for Concrete: Single component, self-leveling.

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
   1. Joint Location:
      a. Joints between concrete and asphalt pavement.
      b. Joints between concrete curbs and asphalt pavement.
   2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.

END OF SECTION 321373

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Kansas City Metropolitan Chapter of APWA Specifications Section 2306 adopted February 15, 2017 or the most Current Addition as amended by the local governing authority apply to the Construction of this project.

1.2 SUMMARY

A. Section includes painted markings applied to asphalt and concrete pavement.

B. Related Requirements:
   1. Section 099123 "Interior Painting" for painting interior concrete surfaces other than pavement.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the latest specifications The Kansas City Metropolitan Chapter of APWA Specifications 2306 as amended by the local governing authority.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 - PRODUCTS

2.1 PAVEMENT-MARKING

1. Lead Fee, Water Borne Emulsion Based Traffic Marking Paint unless noted otherwise on plans.
2. Yellow, White or other Color as Noted on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Allow paving to age for a minimum of 30 days before starting pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
   1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
   2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete and post footings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site .

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 the following:
   a. Fence and gate posts, rails, and fittings.
   b. Chain-link fabric, reinforcements, and attachments.
   c. Accessories: Privacy slats .
   d. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.

C. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence, and gate.

B. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

C. Sample Warranty: For special warranty.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure to comply with performance requirements.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7 .

1. Design Wind Load: As indicated on Drawings .
   a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 8 feet for Material Group IA, ASTM F 1043, Schedule 40 steel pipe .

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter of 0.148 inch .
   a. Mesh Size: 2 inches .
   b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied after weaving.
3. Selvage: Knuckled at both selvages .

2.3 FENCE FRAMEWORK

A. Posts and Rails : ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: 72 inches minimum or as indicated on Drawings .
2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40 .
    a. Line Post: 2.875 inches in diameter .
    b. End, Corner, and Pull Posts: 2.875 inches in diameter .
3. Horizontal Framework Members: Intermediate top and bottom rails according to ASTM F 1043.
    a. Top Rail: 1.66 inches in diameter .
4. Brace Rails: ASTM F 1043.
5. Metallic Coating for Steel Framework:
    a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.

2.4 TENSION WIRE

A. Location: Along bottom of fence fabric.

B. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:
    a. Matching chain-link fabric coating weight.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and single and/or double swing gate types.

1. Gate Leaf Width: As indicated .
2. Framework Member Sizes and Strength: Based on gate fabric height as indicated .

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framework .
2. Gate Posts: Round tubular steel .
3. Gate Frames and Bracing: Round tubular steel .

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Hardware:

1. Hinges: 180-degree inward swing.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Lock: Manufacturer's standard internal device.

2.6 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails to posts.

E. Tension and Brace Bands: Pressed steel .

F. Tension Bars: Steel , length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
   a. Hot-Dip Galvanized Steel: 0.148-inch- diameter wire ; galvanized coating thickness matching coating thickness of chain-link fence fabric.

H. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 2.0 oz./sq. ft. of zinc.

2.7 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    b. Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.
    c. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more . For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 96 inches o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Intermediate and Bottom Rails: Secure to posts with fittings.

I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 ADJUSTING

A. Gates: Adjust 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.

B. Lubricate hardware and other moving parts.

END OF SECTION 323113

SECTION 323223 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes single and multiple depth segmental retaining walls with and without soil reinforcement.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavation for segmental retaining walls.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Project Site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For segmental retaining walls.

1. Wall Designer shall be completed by a Professional Engineer licensed in the State of Missouri.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each type of segmental retaining wall unit and soil reinforcement from manufacturer.

1. Include test data for shear strength between segmental retaining wall units according to ASTM D6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D6638.

C. Product Test Reports: For each type of segmental retaining wall unit and soil reinforcement, for tests performed by a qualified testing agency.

1. Include test data for freeze-thaw durability of segmental retaining wall units.
2. Include test data for shear strength between segmental retaining wall units according to ASTM D6916.
3. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D6638.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D6706.
2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D5321.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based upon line and grade indicated on plans.

B. Delegated Design: Engage a qualified professional engineer licensed in the state of Missouri, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.

C. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

D. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
2. Gravity loads due to existing buildings, and proposed vehicular drives.
3. Wall Designer shall provide a global stability analysis.

2.2 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.
   1. Provide units that comply with requirements in ASTM C1372 for freeze-thaw durability
   2. Provide units that interlock with courses above and below by means of lips, or tongues and grooves.

B. Color: To match existing walls and as selected by Architect from manufacturer's full range.

C. Shape and Texture: Provide units of any basic shape and dimensions that produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with surface and texture comparable to existing and as selected by Architect from manufacturer’s full range.

D. Batter: Provide units that stand near vertical.

E. Cap Units: Provide cap units with smooth, as-cast top surfaces without holes or lugs.

F. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

2.3 INSTALLATION MATERIALS

A. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

B. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base course.

   1. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi.

C. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course and delegated designers engineered drawings.

D. Reinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils and delegated designers engineered drawings.

E. Reinforced-Soil Fill: ASTM D2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; complying with the following gradation according to ASTM C136: 20 to 100 percent passing No. 4 sieve, zero to 60 percent passing No. 40 sieve, zero to 35 percent passing No. 200 sieve, and with fine fraction having a plasticity index of less than 20.

F. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

G. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

H. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D4632.
3. Minimum Weight: 4 oz./sq. yd

I. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement as designated on delegated designers engineered drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in accordance with delegated designers engineered drawings.
2. Form corners and ends by **using special units**

B. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet where such defects are exposed in the completed Work.

C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D698.

D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
1. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.

F. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide," and with segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.
   1. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D698.
      a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D698.
      b. compact reinforced-soil fill that will be more than below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D698.
   2. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.

F. Place impervious fill over top edge of drainage fill layer.

G. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

H. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
   1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
   2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
   3. Do not dump fill material directly from trucks onto geosynthetics.
   4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
   5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1inches in 10 feet, 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1 inch in 10 feet.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inch in 10 feet.

D. Maximum Gap between Units: 1/8 inch.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least one field in-place compaction test for each 150 feet or less of segmental retaining wall length. Refer to engineered drawings for additional requirements.
2. In each compacted backfill layer, perform at least one field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length. Refer to engineered drawings for additional requirements.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved samples, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 323223

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1. APWA Specification Section 2600 as adopted and amended by as amended by the local governing authority.

1.2 SUMMARY

A. Section Includes:
1. Pipe and fittings.
2. Cleanouts.
3. Manholes.
4. Catch basins.
5. Flared end sections.

1.3 ACTION SUBMITTALS

A. Shop Drawings:
1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 REINFORCED CONCRETE PIPE

A. Reinforced Concrete Pipe shall conform to ASTM C76, Class III Wall B. Higher Strength as may be required by the Contract Drawings.
   1. Joints: Flexible gaskets may be either flat gaskets cemented to het pipe lounge or spigot, O-ring gaskets, or roll-on gaskets. All gaskets shall conform to ASTM C 443.

2.2 PE PIPE AND FITTINGS

A. Corrugated PE Pipe and Fittings 4" to 60": Dual Wall AASHTO M 252 and M294, Type S, with smooth waterway for coupling joints as specified in APWA Specifications section 2600.
   1. Water-tight (WT) Couplings: ASTM D3212 for pipe sizes 12" to 60" as noted on plans.
   2. Gaskets: ASTM F 477, elastomeric seals

B. Corrugated PE Pipe and Fittings 4" to 12": Single Wall Perforated/Slotted AASHTO M 252 and M294, Type S, with smooth waterway for coupling joints as specified in APWA Specifications section 2600.
   1. Soil-tight (ST) Couplings: ASTM D3212 for pipe sizes 4" to 12" as noted on plans.

2.3 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM 3034 and ASTM F679, SDR 26, PVC Gasketed sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3212, PVC with bell ends.
   3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Plastic Pipe, Schedule 40:
   1. Pipe and Fittings shall conform to ASTM D1785 and ASTM D2466, respectively.
   2. Joints shall conform to ASTM D 3212 and be push-on type only with a bell-end grooved to receive gasket.
   3. Gaskets: ASTM F 477, elastomeric seals.

2.4 UNDERDRAINS AS SPECIFIED ON CONTRACT DOCUMENTS.

2.5 CLEANOUTS

A. Plastic Cleanouts:
   1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.6 MANHOLES, STORMWATER INLETS AND JUNCTION BOXES

A. Manholes: See Plans for Details and Dimensions - Refer to APWA Specifications Section 2604.

B. Inlets: See Plans for Details and Dimensions- Refer to APWA Specifications Section 2604.

C. Junction Boxes: See Plans for Details and Dimensions- Refer to APWA Specifications Section 2604.

D. Frames and Grates: Refer to APWA Specifications Section 2604.

E. Concrete Flared End Sections and Toe Walls: Refer to APWA Specifications Section 2604.

F. Inlets in City Right of Way shall be in accordance with standard City Details.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow.
   2. Install piping NPS 12 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   3. Install piping with 18-inch minimum cover.
   4. Install PE corrugated sewer piping according to ASTM D 2321.
   5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   6. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.

2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
3. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth with concrete collar 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements and sidewalks. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.
1. Use commercially manufactured tee/wye fittings for piping branch connections. Install Inserta Tee or remove section of existing pipe; install tee/wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Install Inserta Tee or remove section of existing pipe, install tee fitting into existing piping, and

encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections to underground manholes and structures in accordance with APWA specification section 2600. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Option: Test plastic piping according to ASTM F 1417.

b. Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100

GEOTECHNICAL EXPLORATION AND SUBGRADE RECOMMENDATIONS

LEE'S SUMMIT NORTH ROBOTICS BUILDING

Lee's Summit, Missouri

CFS Project No. 22-5545

Prepared For

Lee's Summit R7 School District
301 NE Tudor Road
Lee's Summit, Missouri 64086

August 3, 2022

Prepared by:
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One Vision. One Team. One Call.

SYNOPSIS

A subsurface exploration and an evaluation were performed at the planned Lee's Summit North Robotics Building project site located in Lee's Summit, Missouri to provide geotechnical engineering related recommendations for design and construction of the proposed project.

Exploratory soil borings have been drilled and a laboratory testing program was conducted on selected soil samples. The data has been analyzed based upon the project information provided by the project team.

The results of the exploration and analysis indicate that conventional spread and continuous wall footings appear to be a suitable foundation system for support of the proposed structure. Detailed analysis of subsurface conditions, any alternate foundation types, and pertinent design recommendations are included, herein.

Groundwater conditions are not expected to cause any major difficulties. These conditions will be further discussed in the report. Please note, groundwater levels should be expected to fluctuate based on seasonal changes and precipitation events.

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Appendix A: Figures

Figure 1 – Project Location

Figure 2 – Boring Location Plan

Appendix B: Boring Logs

Geotechnical Exploration
and Foundation Recommendations

LEE'S SUMMIT NORTH ROBOTICS BUILDING
LEE'S SUMMIT, MISSOURI

Project Number: 22-5545
August 3, 2022

1 INTRODUCTION

1.1 PURPOSE

The purpose of this geotechnical exploration was to evaluate the underlying materials at the proposed Lee's Summit North Robotics Building project site, and based upon this information, provide geotechnical engineering related recommendations for design and construction of the planned project. This exploration was performed in accordance with the requirements outlined by the project team and the Lee's Summit R-7 School district's request for proposal (RFP) number R19/20-04 titled "Geotechnical 7 Construction Testing Services" and dated March 17, 2020.

This report includes geotechnical recommendations and considerations pertaining to site development, foundation support and concrete slab on grade construction. Also, included in this report are earthwork, construction and drainage considerations associated with the proposed project.

1.2 SCOPE OF SERVICES

This exploration and analysis included an engineering reconnaissance of the planned site, a subsurface exploration as outlined below, a field and laboratory testing program, and an engineering analysis and evaluation of the subsurface materials.

The scope of services did not include any environmental assessment for wetlands or hazardous materials in the soil, surface water, groundwater, air or surrounding area. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items is strictly for the information of the client.

1.3 GENERAL

The general subsurface conditions used in this analysis are based upon an interpolation of the subsurface data between the borings; varying conditions may be encountered between boring locations. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the Geotechnical Engineer.

The recommendations submitted for the proposed structure are based on the available soil information and the preliminary design details. Any revision in the plans for the proposed structure from those described in this report should be brought to the attention of the Geotechnical Engineer to determine if changes in the foundation recommendations are required.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, and professional advice contained, herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that the Geotechnical Engineer be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and foundation recommendations are properly interpreted and implemented.

2 PROJECT DESCRIPTION

It is understood that the planned project comprises the new construction of a robotics and GiC facility located on the southeast side of the existing Lee's Summit North High School. The facility will consist of a single story, concrete slab on grade building with steel framing. According to Sheet N-C300 titled, "Grading Plan" and developed by Kaw Valley Engineering, the proposed finish floor elevation will be 1035.00 feet above sea level. Foundation loads are expected to be on the order of 100 kips for column footings and two (2) to three (3) kips per linear foot for continuous wall footings.

CFS anticipates minimal cut and fill, less than three (3) feet plus or minus, will be necessary to achieve the desired construction grade. If any changes to the project occur, please notify CFS to allow for review of these changes and, if necessary, amend this report.

2.1 SITE LOCATION & SURFACE CONDITIONS

The project site is located off the southeast corner of the existing Lee's Summit North High School which is located at 901 NE Douglas Street in Lee's Summit, Missouri. The site is bound by the existing high school to the northwest and an access drive to the east, south, and west. Currently, the site is grass covered and slopes downward from the northwest to the southeast.

2.2 SITE GEOLOGY

Soils in the greater Kansas City area are generally residual soils, alluvial deposits, or till. Residual soils formed as a result of weathering of bedrock, or by weathering of sediments that were transported by water, ice, wind, or a combination of these. Regional soils derived from shale, limestone, and loess have high shrink-swell potentials. Major alluvial deposits occur along the Missouri and Kansas rivers and their tributaries. These consist of clay, sand, and gravel sized sediments. Northern parts of the city were glaciated during the early Pleistocene time resulting in till deposits. Surface bedrock in northeastern Kansas and northwestern Missouri generally consist of limestone and shale (with sandstone found in prehistoric channels) arranged in nearly horizontal beds or layers that can be followed continuously over long distances. These bedrocks are part of the Pennsylvanian bedrock system.

3 SUBSURFACE EXPLORATION

Based on the project information as outlined above, CFS Engineers conducted a field exploration to determine the underlying materials at the proposed project site and to establish their engineering characteristics.

3.1 SCOPE OF WORK

This geotechnical exploration consisted of drilling six (6) borings to a planned depth of approximately 20 feet beneath existing site grade within the footprint of the planned structure. The boring locations can be seen on the Boring Location Plan which is included in Appendix A.

The boring locations were determined in the field using measurements from existing landmarks and should be considered accurate only to the degree implied. The locations were established by Cook, Flatt & Strobel Engineers.

Boring logs representing the materials encountered in the borings are included in Appendix B. The boring logs represent CFS Engineers' interpretation of the field logs combined with laboratory observations and testing of the samples. The stratification boundaries indicated on the boring logs were based on field observations, an extrapolation of information obtained by examining samples from the borings, and comparisons of soils and/or bedrock types with similar engineering characteristic. As such, the boundaries between subsurface strata should be expected to vary from the logs to some extent.

The depth to groundwater, if encountered, was recorded in each test boring during drilling and can be seen in Section 3.5, Groundwater Conditions. After completion of drilling, sampling, and field testing, the excavations were backfilled with auger cuttings.

3.2 DRILLING AND SAMPLING PROCEDURES

The auger borings were drilled using a truck mounted SIMCO 2400 drill rig equipped with a rotary head. 3.25-inch solid-stem augers were used to drill the holes. During drilling, field logs were created and maintained by CFS personnel to catalog the materials encountered.

Representative samples were obtained during drilling using split-barrel sampling procedures in general accordance with the procedures for "Standard Test Methods for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM D 1586).

Upon completion of drilling, the samples were then sealed and returned to CFS's laboratory for further examination, classification, and testing. The samples recovered were identified, classified, and evaluated by a Geotechnical Engineer.

3.3 FIELD TESTS AND MEASUREMENTS

During the soil boring procedure, Standard Penetration Tests (SPT) were performed at pre-determined intervals to obtain the standard penetration value of the soil as outlined in the ASTM D1586 test method. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer falling 30 inches, required to advance the split-barrel sampler one foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive increments of six inches penetration. The "N" value is then obtained by adding the second and third incremental numbers. The results of the standard penetration test are shown on the Boring Logs and indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

The Standard Penetration Test (SPT) was also used to evaluate the consistency of the in-situ materials. The N-values for the site's materials were found to range from eight (8) to 13 blows/foot.

3.4 SUBSURFACE CONDITIONS

The materials encountered in the test borings have been visually classified according to the Unified Soil Classification System (USCS). Specific subsurface conditions encountered—including field tests, lab tests, and water level observations—at the boring locations are also presented on the individual boring logs found in Appendix B of this report. The following table presents a general summary of the major strata encountered during this subsurface exploration.

T*able 1: General Subsurface Conditions*

STRATUM	MATERIAL	DEPTH TO TOP OF STRATUM (FT)	DEPTH TO BOTTOM OF STRATUM (FT)	MEASURED N-VALUES	COMMENTS
1	TOPSOIL	0.0	1.0	NA	Dark brown with roots
2	FAT CLAY	1.0	20.0	8 to 13	Brown and dark brown transitioning to gray and brown. Lean clay in boring B1.

Note: the boundaries between subsurface strata should be expected to vary from this table and the logs to some extent.

3.5 GROUNDWATER CONDITIONS

Groundwater was not encountered in the borings at the time of the investigation. Please note, the reported groundwater levels reflect the conditions observed at the time the borings were drilled. Groundwater levels should be expected to fluctuate with changes in grading, precipitation changes and seasonal changes. The water levels included in this report do not indicate a permanent groundwater condition. Additionally, the materials encountered during this exploration are, generally, low permeable soils.

4 LABORATORY TESTING

Upon completion of drilling, the samples were returned to CFS's laboratory located in Kansas City, Kansas for laboratory testing. A supplemental laboratory testing program was conducted to evaluate additional engineering characteristics of the in-situ soils necessary in analyzing the behavior of the support systems for the proposed building.

The laboratory testing program included the following tests:

- Supplementary visual classification (ASTM D2488) of all samples,
- Water content (ASTM D2216) of all samples, and
- Atterberg limit tests (ASTM D4318) on a selected sample.

The results of the laboratory testing program can be seen in on the boring logs in Appendix B. The Atterberg limits can be seen in the following table.

Table 2: Atterberg Limits Results

BORING ID	SAMPLE #	MOISTURE CONTENT (%)	ATTERBERG LIMITS			USCS CLASSIFICATION
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
B1	SPT-1	23.7	45	22	23	LEAN CLAY (CL)
B4	SPT-1	20.0	51	23	28	FAT CLAY (CH)

Based on the Atterberg limits, the overburden material classifies as both Lean Clay (CL) and Fat Clay (CH) and is considered highly expansive. To limit the risk of differential slab movements, all concrete slabs on grade should be constructed in accordance with Section 7.3, "Slab On Grade Recommendations" of this report.

5 GEOTECHNICAL CONCERNS

The following geotechnical concerns are based upon the subsurface materials encountered during this exploration and CFS's understanding of the project as described in Section 2, "Project Description" of this report. If any changes to the planned structure's location, loading or elevations occur, CFS must be allowed to review these changes, and if necessary, issue amendments to this report and its recommendations.

- *Expansive Clay Soils*: Expansive clay soils were encountered during this exploration. The on-site materials are NOT suitable for direct support of concrete slabs and foundation or concrete wall backfill. It is recommended that all walls be backfilled with open graded stone (such as No. 57 as referenced in ASTM C33) extending two (2) feet behind the wall for the entire height of the wall to within 12-inches of the surface to allow for proper drainage and relief of any hydrostatic pressure build-ups that may occur in the native fat clay. All slabs on grade should be supported by a minimum 24-in-thick mat of low volume change material (LVC) constructed in accordance with Section 7.3, "Slab on Grade Recommendations" of this report.

6 EARTHWORK & SITE DEVELOPMENT

6.1 SITE PREPARATION

Prior to filling, the grass and topsoil should be stripped from all structural areas and be stockpiled for later use in landscape areas, or it should be wasted. Any trees and shrubs should be properly removed including the entirety of the root ball and root systems. The upper 12-inches of the subgrade should be moisture conditioned and recompacted, as necessary, to provide a stable subgrade upon which to begin placement of engineered fill.

Upon completion of stripping and prior to filling, the newly exposed subgrade should be evaluated by a qualified professional for stability by means of proof rolling. The proof roll should be conducted using a fully loaded, tandem axle dump truck weighing in excess of 25 tons. Any soft or unsuitable areas

identified during the proof roll should be corrected by means of additional moisture conditioning and recompacting, or removal and replacement with an acceptable material.

Additionally, any undocumented fill encountered during construction should be completely removed from beneath the planned foundations. Please note, approximately three (3) feet of fill was encountered in Boring B6. However, CFS anticipates foundations will penetrate this material or require minimal over excavation to do so. Undocumented fill is any foreign material that was placed or dumped in an uncontrolled manner (i.e. no records of testing exist from the time of placement). Undocumented fill is inconsistent and unpredictable in nature, and it should not be used in support of any foundation systems. Undocumented fill is permitted beneath non load bearing floor slabs given it is thoroughly evaluated by CFS during construction by means of a proof roll outlined above.

6.2 FILL MATERIALS

All general and structural fill should be free of debris and defined by ASTM 2487 as CH, CL, ML, GW, GP, SM, SW, SC, and SP. The onsite soils tend to meet this requirement; however, please note that CH (fat clay) classification materials should NOT be used as structural fill within two (2) feet of the finished grade supporting the building slab and within ten (10) feet laterally outside of the building footprint. Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement without being treated with cement as outlined later in this report.

The on-site topsoil contains organic material and is unsuitable for use as structural fill. Unsuitable materials are those defined by ASTM 2487 as MH, OL, OH, and PT.

6.3 ENGINEERED FILL PLACEMENT

For the purpose of this report, engineered fill means fill placed in controlled layers and compacted and tested according to accepted geotechnical engineering practices to ensure that it meets the required specifications. Structural fill refers to any engineered fill placed within the footprint of the planned structures. Engineered fill materials should be free of organic matter. During placement, engineered fill materials should be within the specified moisture contents and compacted to the specified densities given below in Tables two (2) and three (3). Maximum dry density and optimum moisture content should be determined by the Standard Proctor test (ASTM D 698).

Fill should be placed in six (6) inch lifts (compacted thickness) in mass fill areas, and as needed to obtain the proper compaction in utility trenches and behind walls. Structural fill should extend a minimum of two (2) feet beyond any structure lines. *Additionally, where slopes exist, engineered fill must be properly benched into the existing materials.*

Table 3: Recommended Moisture Ranges

ENGINEERED FILL MATERIAL	MAXIMUM BELOW OPTIMUM	MAXIMUM ABOVE OPTIMUM
Lean Clay (CL)	-2%	+3%
Fat Clay (CH)	0%	+4%
Compacted Base Rock (i.e. MODOT Type 5, AB3 or equivalent)	NA	NA

Table 4: Compaction Requirements & Testing Frequency

LOCATION OR AREA	REQUIED COMPACTION (%) (ASTM D 698, DRY DENSITY)	TESTING FREQUENCY 3 PER LIFT PER …
Building Walkways	95%	20,000 sf
Retaining Walls	95%	1,000 sf
Trenches	95%	150 lf
Lawn or Unimproved Areas	92%	20,000 sf
Structural Fill (i.e., building and pavement subgrades)	95%	10,000 sf
Out-Parcels	95%	20,000 sf

A representative of the Geotechnical Engineer should monitor filling operations on a full-time basis. A sufficient number of density tests should be taken to verify that the specified compaction is obtained. See Table 3 above for required testing frequency.

6.4 EXCAVATIONS & TRENCHES

All temporary slopes and excavations should conform to Occupational Safety and Health Administration (OSHA) Standards for the Construction Industry (29 CFR Part 1926, Subpart P). Excavations at this site are *expected* to be made in "Type B" clayey soil. Soil types should be verified in the field by a competent individual.

All excavations should be kept dry during subgrade preparation. Storm water runoff should be controlled and removed to prevent severe erosion of the subgrade and eliminate free standing water. Subgrade that has been rendered unsuitable from erosion or excessive wetting should be removed and replaced with controlled fill.

Trenches should be excavated so that pipes and culverts can be laid straight at uniform grade between the terminal elevations. Trench width should provide adequate working space and sidewall clearances. Trench subgrade should be removed and replaced with controlled fill if found to be wet, soft, loose, or frozen. Trench sub-grades should be compacted above 95% of the maximum dry density in accordance with ASTM D 698 at moisture contents between -3% to +3% of the optimum moisture content.

Granular bedding materials for pipes, such as well-graded sand or gravel, may be used provided that the bottom of the trench is graded so that water flows away from the structure.

Bedding material should be graded to provide a continuous support beneath all points of the pipe and joints. Embedment material should be deposited and compacted uniformly and simultaneous on each side of the pipe to prevent lateral displacement. Compacted control fill material will be required for the full depth of the trench above the embedment material except in area landscape area with the compaction may be reduced to 90% Standard Proctor ASTM D 698. No backfill should be deposited or compacted in standing water.

Permanent slopes greater than 3 horizontals to 1 vertical should not be used unless additional testing and slope analysis is performed.

6.5 DRAINAGE AND DEWATERING

Normal seasonal weather conditions should be anticipated and planned for during earthwork. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

The site should be graded such that positive drainage (normally 2% minimum) is provided away from any structures. Where sidewalks or paving do not immediately adjoin the building, protective slopes of at least 5% for a minimum of 10 feet from the perimeter walls are recommended. Roof drains and downpours should also be directed away from the building. Open-graded stone is not recommended for use under sidewalks unless the stone is adequately drained to prevent collection of water under the walks.

The site should also be graded to avoid water flows, concentrations, or pools behind retaining walls, curbs or similar structures. When swales are designed at the top of the walls, proper line and slope should be considered to avoid any flow down behind walls. Special attention is needed for sources of storm water from slopes, building roofs, gutter downspouts and paved areas draining to one point.

Perforated plastic pipes should be placed on the backfilled side of the walls near the bottom and day-lighted. Six inches of open graded crushed rock wrapped with geo-textile fabric should be placed behind the walls up to a depth of two feet below the finished grade. As an alternative to the open graded crushed rock, a manufactured geo-composite sheet drain such as Mirafi G100N, Contech C-Drain, or equivalent, may be used in conjunction with the perforated pipe.

6.6 LANDSCAPING

Landscaping and irrigation should be limited adjacent to buildings and pavements to reduce the potential for large moisture changes. Trees and large bushes can develop intricate root systems that can draw moisture from the subgrade, resulting in shrinkage of the bearing material during dry periods of the year. Desiccation of bearing material below foundations may result in foundation settlement.

Landscaped areas near pavements and sidewalks should include a drainage system that prevents over saturation of the subgrade beneath asphalt and concrete surfaces. Drainage systems in irrigation areas should be incorporated into the storm drain system.

7 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

7.1 FOUNDATIONS RECOMMENDATIONS

Conventional spread and continuous wall footings are, generally, most economical when the existing soil conditions allow them to be founded at shallow depths on existing materials. Based on the materials encountered during this exploration, it is CFS Engineers' opinion that the planned structure can be supported by a shallow foundation system, such as spread and/or trench footings bearing in native clay soils. Please reference the following table for recommended design parameters.

Table 5: Shallow Foundation Design Parameters

DESIGN PARAMETER	RECOMMENDED VALUE	COMMENTS
Allowable Bearing Capacity (1) (shallow foundations)	2,500 psf	Evaluated based on field and laboratory testing results (1).
Recommended Bearing Material (2)	FAT CLAY (CH)	Uniform bearing material required beneath entirety of foundation system (2).
Anticipated Total Settlement	< 1-inch	Maximum
Anticipated Differential Settlement	< ¾ -inch	Maximum per 100 feet of linear footing
Minimum Recommended width	24 and 16 inches	Spread and trench, respectively
Minimum Recommended Depth	36-inches	Based on seasonal freeze-thaw cycles

(1) If over excavation of any footing is required to reach design bearing capacity, backfill of the footing should be done with lean concrete.
(2) A uniform bearing condition should exist beneath the entirety of the foundation system for a given structure. A representative of the Geotechnical Engineer should test the materials in the footing excavations to verify the material and design bearing pressure.

If over excavation of footings becomes necessary to achieve the desired bearing pressure or a uniform bearing condition, backfill of the footing should be done with lean concrete. Footings should be suitably reinforced to reduce the effects of differential movement that may occur due to variations in the properties of the supporting soils. Top and bottom reinforcing steel is recommended for continuous wall footings to reduce differential settlement due to possible varying bearing capacities of the existing fill soils.

Every effort should be made to keep the footing excavations dry as the soils will tend to soften when exposed to free water. Footing bottoms should be free of loose soil and concrete should be placed as soon as possible to prevent drying of the foundation soils.

7.2 SEISMIC ANALYSIS

The determination of the seismic class is based on ASCE Standard 7: Minimum Design Loads for Building and Other Structures. Based upon this information, the seismic properties of the soil were interpolated

from the standard penetration test values. A Seismic Site Class "D" was determined for this site. In addition, there is no significant risk of liquefaction or mass movement of the on-site soils due to a seismic event.

7.3 SLAB ON GRADE RECOMMENDATIONS

In its current state, the overburden materials (i.e., Fat Clay) encountered during this exploration are unsuitable for direct support of the planned slab on grade. CFS recommends all concrete slabs on grade be supported by a minimum of 24-inches of Low Volume Change (LVC) material. LVC material should consist of lean clay (CL), KDOT AB3, crushed limestone screenings or equivalent. A low volume change material is defined as a material with a liquid limit less than 45 and a plasticity index less than 25. The subgrade can be constructed as outlined below.

1. Cut the subgrade to a minimum depth of 24-inches beneath the planned bottom of slab elevation. The exposed material at this depth should be moisture conditioned and re-compacted, as necessary, to pass a proof roll as specified in Section 6.1, "Site Preparation" of this report.

2. Twenty (20) inches of a compacted LVC material should be placed atop the exposed slab subgrade. The LVC should be placed in lifts no greater than 8-inches-thick (compacted thickness) and compacted to 95% of the maximum dry density as determined by ASTM 698. Limestone based LVC material should be compacted at a moisture content sufficient to achieve the desired compaction, and lean clay (CL) material should be compacted at a moisture content between 0 and +4% of optimum. Please note, if lean clay is utilized as LVC, CFS recommends it be capped with 6-inches of limestone based LVC to ease construction and protect the subgrade from excessive drying and wetting.

3. A 4-inch-thick layer of open graded stone (ASTM C33 or equivalent material) should be placed atop the 20-inches of compacted LVC material to return the subgrade to the original bottom of slab elevation. The open-graded stone will ease construction and provide a capillary break between the LVC and concrete slab.

Based on the materials encountered, 100 psi/in can be used as a modulus of subgrade reaction (k_s) for fat or lean clay soils. A subgrade reaction modulus value of 150 psi/in can be used for 20-inches of compacted granular fill such as KDOT AB3, MODOT Type 5 or equivalent.

Every floor slab should be evaluated to determine if a vapor retarder under the concrete floor is required. The slab designer should refer to ACI 302 and/or ACI 360 for procedures regarding the use and placement of a vapor retarder.

To reduce the effects of differential movement, slabs-on-grade should not be rigidly connected to columns, walls, or foundations unless it is designed to withstand the additional resultant forces. Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction. Expansion joints may be used to allow unrestrained vertical movement of the slabs. The floor slabs should be designed to have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage. CFS suggests joints be provided on a minimum spacing of twelve (12) feet on center. For additional recommendations refer to the ACI Design Manual.

The requirements for the slab reinforcement should be established by the designer based on experience and the intended slab use.

7.4 LATERAL EARTH PRESSURES

Lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient. If the foundation walls are rigidly attached to the building and not free to rotate or deflect at the top, CFS recommends designing the walls for the *at-rest* earth pressure coefficient. Walls that are permitted to rotate and deflect at the top can be designed for the *active* lateral earth pressure condition. Horizontal loads acting on shallow foundations are resisted by friction along the foundation base and by *passive* pressure against the footing face that is perpendicular to the line of applied force.

It is recommended that all walls be backfilled with open graded stone (such as No. 57 as referenced in ASTM C33) extending to two (2) feet behind the wall for the entire height of the wall to within 12-inches of the surface to allow for proper drainage and relief of any hydrostatic pressure build-ups that may occur in the native clay. The use of stone to backfill behind the walls will expedite construction, reduce potential settlement between the wall and the floor slab and lower the pressure induced on the wall from the backfill thus potentially reducing the thickness of the walls.

Table 6: Earth Pressure and Friction Coefficients

MATERIAL	ACTIVE (K_a)	PASSIVE (K_p)	AT-REST (K_o)	ALLOWABLE BASE FRICTION	UNIT WEIGHT (pcf)
Open-graded crushed limestone	0.27	3.69	0.43	0.47	130-140
In-situ lean clay soils	0.40	2.5	0.68	0.32	120-125
In-situ fat clay soils	0.49	2.04	0.66	0.24	120-125
Lean clay – conditioned and compacted	0.32	3.12	0.48	0.35	120-125
Fat clay/Weathered Shale – conditioned and compacted	0.45	2.2	0.63	0.27	120-130
Limestone Bedrock	-	-	-	0.55	140-150

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading, or a sloping backfill. Nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied upon to provide some level of passive resistance should be placed in lifts not exceeding six (6) inches in thickness and compacted to a minimum density of 95% of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within +- 3% of the optimum moisture content. It is recommended that a representative of CFS should verify the compaction of any such materials relied upon to provide passive pressure.

The actual earth pressure on the walls will vary according to material types and backfill materials used and how the backfill is compacted. If the backfill conditions are different than the ones used above, CFS should be notified so the recommendations can be modified. The buildup of water behind a wall will increase the lateral pressure imposed on below-grade walls. Adequate drainage should be provided behind any below grade walls as described in this report. The walls should also be designed for appropriate surcharge pressures such as adjacent traffic, interior building floor slab loads, and construction equipment.

8 GENERAL COMMENTS

When the plans and specifications are complete, or if significant changes are made in the character or location of the proposed building, a consultation should be arranged to review the changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of Cook, Flatt & Strobel Engineers be engaged to test and evaluate the compaction of any additional fill materials and to test and evaluate the bearing value of the soils in the footing excavations.

Respectfully submitted,

COOK, FLATT & STROBEL ENGINEERS, P.A.

Jacob Engler, P.E.
Geotechnical Engineer

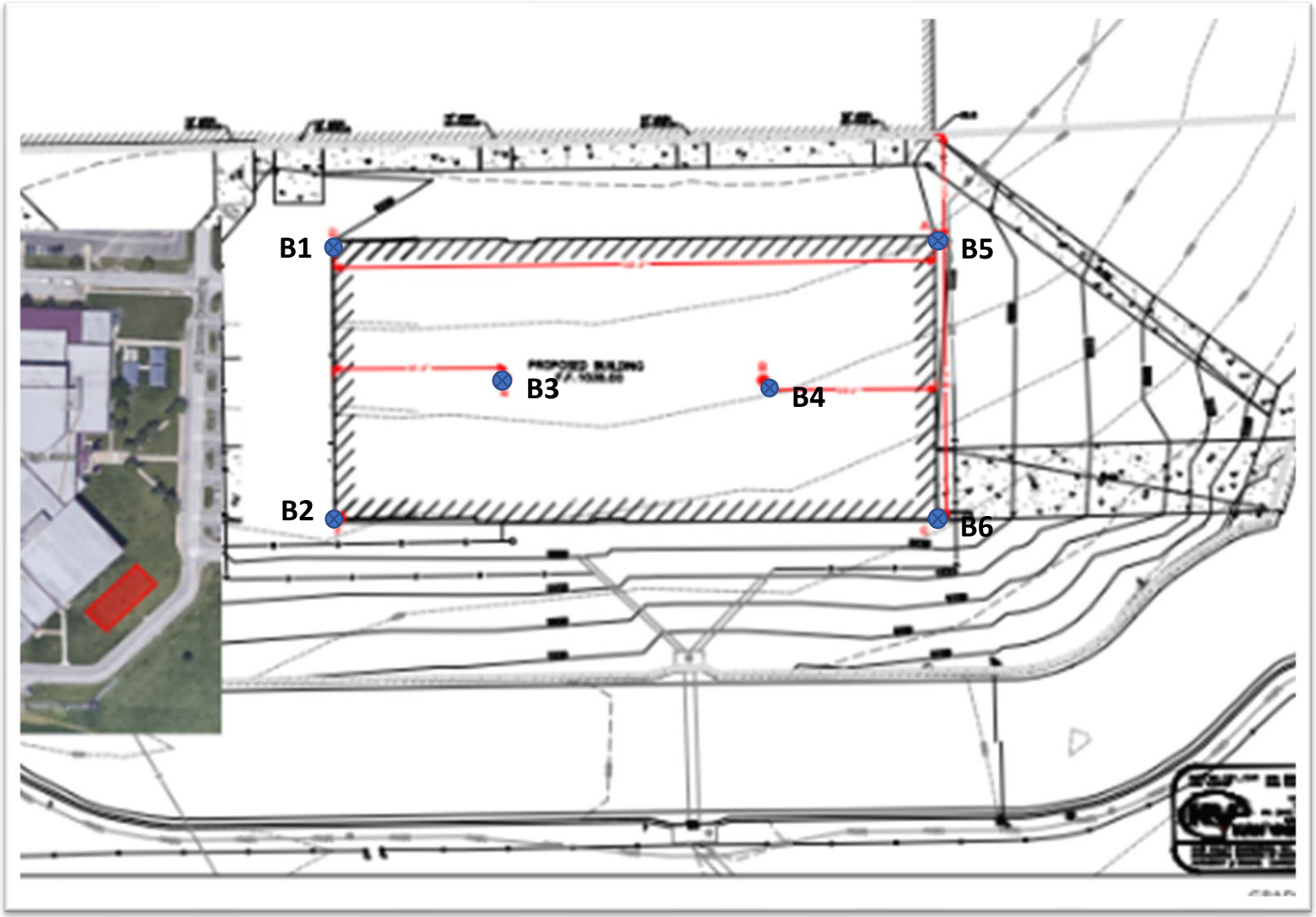
Reviewed by: Adam McEachron, P.E.
Senior Geotechnical Engineer

Appendix A: Figures

CFS ENGINEERS

1100 W. Cambridge Circle Dr, Ste 700
Kansas City, Kansas 66103

Project: **LEE'S SUMMIT NORTH ROBOTICS BUILDING**		Project #: 22-5545	Figure 1: **SITE LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 School District		
Date:	8/3/2022		



CFS ENGINEERS

1100 W. Cambridge Circle Dr, Ste 700
Kansas City, Kansas 66103

Project:	**LEE'S SUMMIT NORTH ROBOTICS BUILDING**	Project #: 22-5545	Figure 2: **BORING LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 School District		
Date:	8/3/2022		

Appendix B: Boring Logs

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B1

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT NORTH ROBOTICS BUILDING
PROJECT NUMBER 22-5545
PROJECT LOCATION Lee's Summit
DATE STARTED 07/08/22 **COMPLETED** 07/08/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		LEAN CLAY, (CL) dark brown, with vegetation (TOPSOIL)										
		LEAN CLAY, (CL) grayish brown and dark brown, moist, stiff, with iron nodules	SPT 1	100	4-4-6 (10)	4		23.7	45	22	23	
			SPT 2	100	4-4-7 (11)	3		25.6				
5		FAT CLAY, (CH) grayish brown, moist, stiff, with iron nodules	SPT 3	100	4-4-6 (10)	2.5		24.8				
		(CH) gray and brown below 8'	SPT 4	100	3-3-6 (9)	2.5		24.3				
10												
			SPT 5	100	4-4-6 (10)	2.5		30.1				
15												
		(CH) shaley below 18'	SPT 6	100	4-5-8 (13)	3		26.0				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B2

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT NORTH ROBOTICS BUILDING
PROJECT NUMBER 22-5545
PROJECT LOCATION Lee's Summit
DATE STARTED 07/08/22 **COMPLETED** 07/08/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		LEAN CLAY, (CL) dark brown, with vegetation (TOPSOIL)										
		FAT CLAY, (CH) brown and dark brown, moist, stiff, with iron nodules	SPT 1	100	4-5-5 (10)	4.5		19.2				
			SPT 2	44	3-4-5 (9)	3.5		19.0				
5		(CH) gray and brown below 6'	SPT 3	100	3-5-6 (11)	2		25.5				
			SPT 4	100	3-4-5 (9)	3		24.8				
10												
			SPT 5	83	4-2-7 (9)	2.5		26.9				
15												
			SPT 6	100	4-5-6 (11)	2		26.6				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B3

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT NORTH ROBOTICS BUILDING
PROJECT NUMBER 22-5545
PROJECT LOCATION Lee's Summit
DATE STARTED 07/08/22 **COMPLETED** 07/08/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		LEAN CLAY, (CL) dark brown, with vegetation (TOPSOIL)										
		FAT CLAY, (CH) reddish brown and dark brown, dry, stiff, with trace of roots	SPT 1	83	4-4-5 (9)	4.5		18.4				
		(CH) brown and dark brown, with iron nodules below 3'	SPT 2	100	3-4-7 (11)	3.5		25.6				
5			SPT 3	100	4-6-4 (10)	1.5		30.2				
			SPT 4	100	4-5-7 (12)	2		27.8				
10												
		(CH) gray and brown below 13'	SPT 5	100	4-4-5 (9)	2.5		28.1				
15												
			SPT 6	100	4-4-5 (9)	2.5		25.8				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B4

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT NORTH ROBOTICS BUILDING
PROJECT NUMBER 22-5545
PROJECT LOCATION Lee's Summit
DATE STARTED 07/08/22 **COMPLETED** 07/08/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		LEAN CLAY, (CL) dark brown, with vegetation (TOPSOIL)										
		FAT CLAY, (CH) brown and dark brown, dry, stiff, with iron nodules	SPT 1	100	4-4-5 (9)	4		20.0	51	23	28	
		(CH) moist below 3'	SPT 2	100	3-4-5 (9)	2		23.6				
5			SPT 3	100	3-4-6 (10)	2		24.8				
		(CH) grayish brown below 8'	SPT 4	100	3-4-5 (9)	1.5		27.9				
10												
		(CH) gray and brown below 13'	SPT 5	100	2-4-6 (10)	1.5		30.2				
15												
		(CH) shaley below 18'	SPT 6	100	3-4-6 (10)	3		25.3				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B5

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT NORTH ROBOTICS BUILDING
PROJECT NUMBER 22-5545
PROJECT LOCATION Lee's Summit
DATE STARTED 07/08/22 **COMPLETED** 07/08/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		LEAN CLAY, (CL) dark brown, with vegetation (TOPSOIL)										
		FAT CLAY, (CH) reddish brown and dark brown, moist, stiff, with iron nodules	SPT 1	100	3-5-5 (10)	4.5		19.9				
			SPT 2	100	3-4-6 (10)	3		24.9				
5		(CH) tan and dark brown below 6'	SPT 3	100	3-4-6 (10)	2		22.0				
			SPT 4	100	3-5-8 (13)	2		30.9				
10		(CH) gray and brown below 13'	SPT 5	100	3-4-5 (9)	1.5		26.9				
15												
			SPT 6	100	3-4-7 (11)	3		48.5				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B6

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT NORTH ROBOTICS BUILDING
PROJECT NUMBER 22-5545
PROJECT LOCATION Lee's Summit
DATE STARTED 07/08/22 **COMPLETED** 07/08/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		FAT CLAY, (CH) brown and reddish brown, dry, with roots (FILL)										
			SPT 1	83	5-4-5 (9)	3		1.7				
		(CH) dark brown below 3'										
			SPT 2	89	3-3-5 (8)	1.5		28.1				
5												
		FAT CLAY, (CH) grayish brown, moist, stiff, with iron nodules	SPT 3	89	2-4-5 (9)	2.5		26.4				
			SPT 4	94	2-4-5 (9)	1.5		28.2				
10												
		(CH) gray and brown below 13'										
			SPT 5	100	3-4-6 (10)	2		27.5				
15												
		(CH) shaley below 18'										
			SPT 6	100	3-4-7 (11)	2.5		25.1				
20												

Bottom of borehole at 20.0 feet.

GEOTECHNICAL EXPLORATION AND SUBGRADE RECOMMENDATIONS

LEE'S SUMMIT HIGH SCHOOL ROBOTICS ADDITIONS

Lee's Summit, Missouri

CFS Project No. 22-5546

Prepared For

Lee's Summit R7 School District
301 NE Tudor Road
Lee's Summit, Missouri 64086

August 3, 2022

Prepared by:
Cook, Flatt & Strobel Engineers, P.A.
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103
913.627.9040

One Vision. One Team. One Call.

SYNOPSIS

A subsurface exploration and an evaluation were performed at the planned Lee's Summit High School Robotics Addition project sites to provide geotechnical engineering related recommendations for design and construction of the proposed project.

Exploratory soil borings have been drilled and a laboratory testing program was conducted on selected soil samples. The data has been analyzed based upon the project information provided by the project team.

The results of the exploration and analysis indicate that conventional spread and continuous wall footings appear to be a suitable foundation system for support of the proposed structure. Please note, approximately three (3) to six (6) feet of undocumented fill was encountered beneath the ground surface at project sites. The footings in these areas should be over excavated to native clay soils and lean concrete can be utilized to return the over excavation depth to the planned bearing elevation. Alternatively, the undocumented fill can be entirely removed and replaced with engineered fill prior to construction of the addition. This may be advantageous given the extent of the existing site utilities which will likely have to be relocated and filled with engineered controlled fill.

Detailed analysis of subsurface conditions, any alternate foundation types, and pertinent design recommendations are included, herein. Groundwater conditions are not expected to cause any major difficulties. These conditions will be further discussed in the report. Please note, groundwater levels should be expected to fluctuate based on seasonal changes and precipitation events.

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Appendix A: Figures

Figure 1 – Project Location

Figure 2 – Boring Location Plan

Appendix B: Boring Logs

Geotechnical Exploration
and Foundation Recommendations

LEE'S SUMMIT HIGH SCHOOL ROBOTICS ADDITIONS
LEE'S SUMMIT, MISSOURI

Project Number: 22-5546
August 23, 2022

1 INTRODUCTION

1.1 PURPOSE

The purpose of this geotechnical exploration was to evaluate the underlying materials at the proposed Lee's Summit High School Robotics Addition project site and based upon this information, provide geotechnical engineering related recommendations for design and construction of the planned project. This exploration was performed in accordance with the requirements outlined by the project team and the Lee's Summit R-7 School district's request for proposal (RFP) number R19/20-04 titled "Geotechnical 7 Construction Testing Services" and dated March 17, 2020.

This report includes geotechnical recommendations and considerations pertaining to site development, foundation support, and concrete slab on grade construction. Also, included in this report are earthwork, construction and drainage considerations associated with the proposed project.

1.2 SCOPE OF SERVICES

This exploration and analysis included an engineering reconnaissance of the planned site, a subsurface exploration as outlined below, a field and laboratory testing program, and an engineering analysis and evaluation of the subsurface materials.

The scope of services did not include any environmental assessment for wetlands or hazardous materials in the soil, surface water, groundwater, air or surrounding area. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items is strictly for the information of the client.

1.3 GENERAL

The general subsurface conditions used in this analysis are based upon an interpolation of the subsurface data between the borings; varying conditions may be encountered between boring locations. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the Geotechnical Engineer.

The recommendations submitted for the proposed structure are based on the available soil information and the preliminary design details. Any revision in the plans for the proposed structure from those described in this report should be brought to the attention of the Geotechnical Engineer to determine if changes in the foundation recommendations are required.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, and professional advice contained, herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that the Geotechnical Engineer be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and foundation recommendations are properly interpreted and implemented.

2 PROJECT DESCRIPTION

It is understood that the planned project comprises two (2) robotics lab building additions to the existing structures located on the north side of the existing tennis courts at Lee's Summit High School. One addition will be located on the north side of the east building, and the other addition will be located on the south side of the west building. The additions will be steel framed with concrete slab on grade construction. The proposed finish floor elevations were not available at the time of this exploration, however, CFS anticipates they will be similar to that of the existing buildings. Foundation loads are expected to be on the order of 100 kips for column footings and two (2) to three (3) kips per linear foot for continuous wall footings.

CFS anticipates minimal cut and fill, less than two (2) feet plus or minus, will be necessary to achieve the desired construction grades. If any changes to the project occur, please notify CFS to allow for review of these changes and, if necessary, amend this report.

2.1 SITE LOCATION & SURFACE CONDITIONS

The project site is the existing Lee's Summit High School Campus, specifically the two (2) buildings on the north side of the existing tennis courts. One addition will be located on the north side of the east building, and the other addition will be located on the south side of the west building.

Currently, the project sites are primarily asphalt covered. The have subtle downward slopes away from the structures.

2.2 SITE GEOLOGY

Soils in the greater Kansas City area are generally residual soils, alluvial deposits, or till. Residual soils formed as a result of weathering of bedrock, or by weathering of sediments that were transported by water, ice, wind or a combination of these. Regional soils derived from shale, limestone, and loess have high shrink-swell potentials. Major alluvial deposits occur along the Missouri and Kansas rivers and their tributaries. These consist of clay, sand and gravel sized sediments. Northern parts of the city were glaciated during the early Pleistocene time resulting in till deposits. Surface bedrock in northeastern Kansas and northwestern Missouri generally consist of limestone and shale (with sandstone found in prehistoric channels) arranged in nearly horizontal beds or layers that can be followed continuously over long distances. These bedrocks are part of the Pennsylvanian bedrock system.

3 SUBSURFACE EXPLORATION

Based on the project information as outlined above, CFS Engineers conducted a field exploration to determine the underlying materials at the proposed project site and to establish their engineering characteristics.

3.1 SCOPE OF WORK

This geotechnical exploration consisted of drilling four (4) borings to a depth of approximately 20 feet beneath existing site grade within the footprint of the planned additions. Please note, one (1) boring was offset and redrilled due to encountered in a buried waterline. Additionally, more borings were originally planned, but they had to be abandoned due to buried utilities. The borings were drilled to their planned depth or refusal, whichever occurred first. The boring locations can be seen on the Boring Location Plan which is included in Appendix A.

The boring locations were determined in the field using measurements from existing landmarks and should be considered accurate only to the degree implied. The locations were established by Cook, Flatt & Strobel Engineers.

Boring logs representing the materials encountered in the borings are included in Appendix B. The boring logs represent CFS Engineers' interpretation of the field logs combined with laboratory observations and testing of the samples. The stratification boundaries indicated on the boring logs were based on field observations, an extrapolation of information obtained by examining samples from the borings, and comparisons of soils and/or bedrock types with similar engineering characteristic. As such, the boundaries between subsurface strata should be expected to vary from the logs to some extent.

The depth to groundwater, if encountered, was recorded in each test boring during drilling and can be seen in Section 3.5, Groundwater Conditions. After completion of drilling, sampling, and field testing, the excavations were backfilled with auger cuttings.

3.2 DRILLING AND SAMPLING PROCEDURES

The auger borings were drilled using a truck mounted SIMCO 2400 drill rig equipped with a rotary head. 3.25-inch solid-stem augers were used to drill the holes. During drilling, field logs were created and maintained by CFS personnel to catalog the materials encountered.

Representative samples were obtained during drilling using split-barrel sampling procedures in general accordance with the procedures for "Standard Test Methods for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM D 1586).

Upon completion of drilling, the samples were then sealed and returned to CFS's laboratory for further examination, classification, and testing. The samples recovered were identified, classified, and evaluated by a Geotechnical Engineer.

3.3 FIELD TESTS AND MEASUREMENTS

During the soil boring procedure, Standard Penetration Tests (SPT) were performed at pre-determined intervals to obtain the standard penetration value of the soil as outlined in the ASTM D1586 test method.

The standard penetration value (N) is defined as the number of blows of a 140-pound hammer falling 30 inches, required to advance the split-barrel sampler one foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive increments of six inches penetration. The "N" value is then obtained by adding the second and third incremental numbers. The results of the standard penetration test are shown on the Boring Logs and indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

The Standard Penetration Test (SPT) was also used to evaluate the consistency of the in-situ materials. The N-values for the site's materials were found to range from three (3) to 50+ blows/foot.

3.4 SUBSURFACE CONDITIONS

The materials encountered in the test borings have been visually classified according to the Unified Soil Classification System (USCS). Specific subsurface conditions encountered—including field tests, lab tests, and water level observations—at the boring locations are also presented on the individual boring logs found in Appendix B of this report. The following table presents a general summary of the major strata encountered during this subsurface exploration.

T*able 1: General Subsurface Conditions*

ADDITION ID	STRATUM	MATERIAL	DEPTH TO TOP OF STRATUM (FT)	DEPTH TO BOTTOM OF STRATUM (FT)	MEASURED N-VALUES	COMMENTS
NORTH ADDITION	1	ASPHALT	0.0	0.5	NA	NA
	2	FILL	0.5	3.0 to 6.0	NA	Bluish gray, dark brown, and grayish brown, moist with gravel.
	3	CLAY SOIL	3.0 to 6.0	13	3 to 7	Bluish gray, gray, and tan. Moist, soft to medium stiff.
	4	LEAN CLAY, SILTY	3.0 to 6.0	20.0	5 to 8	Dark gray, moist, medium stiff.
SOUTH ADDITION	1	ASPHALT	0.0	0.5	NA	NA
	2	FILL	0.5	6.0	NA	Dark brown and brown with gravel.
	3	CLAY SOIL	6.0	13.0	NA	Brownish olive and gray, moist, stiff.
	4	SHALE	13.0	18.0	50+	Tannish olive and fresh

Note: the boundaries between subsurface strata should be expected to vary from this table and the logs to some extent.

3.5 GROUNDWATER CONDITIONS

Free water was encountered during drilling at a depth of approximately 13 to 18 feet beneath existing grade in the northern building addition site. The reported groundwater levels reflect the conditions observed at the time the borings were drilled. Groundwater levels should be expected to fluctuate with changes in grading, precipitation changes and seasonal changes. The water levels included in this report do not indicate a permanent groundwater condition. Additionally, the materials encountered during this exploration are, generally, low permeable soils.

4 LABORATORY TESTING

Upon completion of drilling, the samples were returned to CFS's laboratory located in Kansas City, Kansas for laboratory testing. A supplemental laboratory testing program was conducted to evaluate additional engineering characteristics of the in-situ soils necessary in analyzing the behavior of the support systems for the proposed building.

The laboratory testing program included the following tests:

- Supplementary visual classification (ASTM D2488) of all samples,
- Water content (ASTM D2216) of all samples, and
- Atterberg limit tests (ASTM D4318) on a selected sample.

The results of the laboratory testing program can be seen in on the boring logs in Appendix B. The Atterberg limits can be seen in the following table.

Table 2: Atterberg Limits Results

BORING ID	SAMPLE #	MOISTURE CONTENT (%)	ATTERBERG LIMITS			USCS CLASSIFICATION
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
B1	SPT-1	19.4	45	22	23	LEAN CLAY (CL)

Based on the Atterberg limits, the overburden material classifies as Lean Clay (CL) and is considered highly expansive. To limit the risk of differential slab movements, all concrete slabs on grade should be constructed in accordance with Section 7.3, "Slab On Grade Recommendations" of this report.

5 GEOTECHNICAL CONCERNS

The following geotechnical concerns are based upon the subsurface materials encountered during this exploration and CFS's understanding of the project as described in Section 2, "Project Description" of this report. If any changes to the planned structure's location, loading or elevations occur, CFS must be allowed to review these changes, and if necessary, issue amendments to this report and its recommendations.

1. *Undocumented Fill*: Approximately three (3) to six (6) feet of undocumented fill was encountered beneath the ground surface at the addition sites. Undocumented fill is any foreign material that was placed or dumped in an uncontrolled manner (i.e. no records of testing exist from the time of

placement). Undocumented fill is inconsistent and unpredictable in nature, and it should not be used in support of any foundation systems. If encountered during construction, the foundations should be over excavated to native clay soils. Lean concrete can be utilized to return the over excavation depth to the planned bearing elevation. Undocumented fill is permitted beneath non load bearing floor slabs given it is thoroughly evaluated by CFS during construction by means of a proof roll outlined above.

2. *Existing Buried Utilities*: CFS anticipates a variety of existing utilities will need to be relocated prior to construction of the new additions. Once complete, it is important that these excavations be filled with engineered controlled fill, since it is likely the new foundations will overlap these excavations. Depending on the depth and extent of the existing fill, it may be advantageous to remove and replace the undocumented fill at the time of relocating the existing utilities, as well. This should negate the need to over excavate the proposed foundations to a suitable material. CFS can help evaluate this during construction, if desired.

3. *Differential Settlement Between Structures*: The existing structure has likely already undergone most, if not all, of its total settlement. Thus, the anticipated amount of total settlement of the new building addition will be differential with respect to the existing structure if the two (2) are rigidly connected. To mitigate the risk of damage caused by differential movements between the structures, expansion joints and other design techniques should be implemented to allow for independent movement of the building addition.

4. *Expansive Clay Soils*: Expansive clay soils were encountered during this exploration. The on-site materials are NOT suitable for direct support of concrete slabs and foundation or concrete wall backfill. It is recommended that all walls be backfilled with open graded stone (such as No. 57 as referenced in ASTM C33) extending two (2) feet behind the wall for the entire height of the wall to within 12-inches of the surface to allow for proper drainage and relief of any hydrostatic pressure build-ups that may occur in the native fat clay. All slabs on grade should be supported by a minimum 24-in-thick mat of low volume change material (LVC) constructed in accordance with Section 7.3, "Slab on Grade Recommendations" of this report.

6 EARTHWORK & SITE DEVELOPMENT

6.1 SITE PREPARATION

Prior to filling, the grass and topsoil should be stripped from all structural areas and be stockpiled for later use in landscape areas, or it should be wasted. Any trees and shrubs should be properly removed including the entirety of the root ball and root systems. The upper 12-inches of the subgrade should be moisture conditioned and recompacted, as necessary, to provide a stable subgrade upon which to begin placement of engineered fill.

Upon completion of stripping and prior to filling, the newly exposed subgrade should be evaluated by a qualified professional for stability by means of proof rolling. The proof roll should be conducted using a fully loaded, tandem axle dump truck weighing in excess of 25 tons. Any soft or unsuitable areas identified during the proof roll should be corrected by means of additional moisture conditioning and recompacting, or removal and replacement with an acceptable material.

Additionally, any undocumented fill encountered during construction should be completely removed from beneath the planned foundations. Undocumented fill is any foreign material that was placed or dumped in an uncontrolled manner (i.e. no records of testing exist from the time of placement). Undocumented fill is inconsistent and unpredictable in nature, and it should not be used in support of any foundation systems. Undocumented fill is permitted beneath non load bearing floor slabs given it is thoroughly evaluated by CFS during construction by means of a proof roll outlined above.

6.2 FILL MATERIALS

All general and structural fill should be free of debris and defined by ASTM 2487 as CH, CL, ML, GW, GP, SM, SW, SC, and SP. The onsite soils tend to meet this requirement; however, please note that CH (fat clay) classification materials should NOT be used as structural fill within two (2) feet of the finished grade supporting the building slab and within ten (10) feet laterally outside of the building footprint. Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement without being treated with cement as outlined later in this report.

The on-site topsoil contains organic material and is unsuitable for use as structural fill. Unsuitable materials are those defined by ASTM 2487 as MH, OL, OH, and PT.

6.3 ENGINEERED FILL PLACEMENT

For the purpose of this report, engineered fill means fill placed in controlled layers and compacted and tested according to accepted geotechnical engineering practices to ensure that it meets the required specifications. Structural fill refers to any engineered fill placed within the footprint of the planned structures or pavements. Engineered fill materials should be free of organic matter. During placement, engineered fill materials should be within the specified moisture contents and compacted to the specified densities given below in Tables two (2) and three (3). Maximum dry density and optimum moisture content should be determined by the Standard Proctor test (ASTM D 698).

Fill should be placed in six (6) inch lifts (compacted thickness) in mass fill areas, and as needed to obtain the proper compaction in utility trenches and behind walls. Structural fill should extend a minimum of two (2) feet beyond any structure lines. *Additionally, where slopes exist, engineered fill must be properly benched into the existing materials.*

Table 3: Recommended Moisture Ranges

ENGINEERED FILL MATERIAL	MAXIMUM BELOW OPTIMUM	MAXIMUM ABOVE OPTIMUM
Lean Clay (CL)	-2%	+3%
Fat Clay (CH)	0%	+4%
Compacted Base Rock (i.e. MODOT Type 5, AB3 or equivalent)	NA	NA

Table 4: Compaction Requirements & Testing Frequency

LOCATION OR AREA	REQUIED COMPACTION (%) (ASTM D 698, DRY DENSITY)	TESTING FREQUENCY 3 PER LIFT PER …
Building Walkways	95%	20,000 sf
Retaining Walls	95%	1,000 sf
Trenches	95%	150 lf
Lawn or Unimproved Areas	92%	20,000 sf
Structural Fill (i.e., building and pavement subgrades)	95%	10,000 sf
Out-Parcels	95%	20,000 sf

A representative of the Geotechnical Engineer should monitor filling operations on a full-time basis. A sufficient number of density tests should be taken to verify that the specified compaction is obtained. See Table 3 above for required testing frequency.

6.4 EXCAVATIONS & TRENCHES

All temporary slopes and excavations should conform to Occupational Safety and Health Administration (OSHA) Standards for the Construction Industry (29 CFR Part 1926, Subpart P). Excavations at this site are *expected* to be made in "Type C" clayey soil. Soil types should be verified in the field by a competent individual.

All excavations should be kept dry during subgrade preparation. Storm water runoff should be controlled and removed to prevent severe erosion of the subgrade and eliminate free standing water. Subgrade that has been rendered unsuitable from erosion or excessive wetting should be removed and replaced with controlled fill.

Trenches should be excavated so that pipes and culverts can be laid straight at uniform grade between the terminal elevations. Trench width should provide adequate working space and sidewall clearances. Trench subgrade should be removed and replaced with controlled fill if found to be wet, soft, loose, or frozen. Trench sub-grades should be compacted above 95% of the maximum dry density in accordance with ASTM D 698 at moisture contents between -3% to +3% of the optimum moisture content.

Granular bedding materials for pipes, such as well-graded sand or gravel, may be used provided that the bottom of the trench is graded so that water flows away from the structure.

Bedding material should be graded to provide a continuous support beneath all points of the pipe and joints. Embedment material should be deposited and compacted uniformly and simultaneous on each side of the pipe to prevent lateral displacement. Compacted control fill material will be required for the full depth of the trench above the embedment material except in area landscape area with the compaction may be reduced to 90% Standard Proctor ASTM D 698. No backfill should be deposited or compacted in standing water.

Permanent slopes greater than 3 horizontals to 1 vertical should not be used unless additional testing and slope analysis is performed.

6.5 DRAINAGE AND DEWATERING

Normal seasonal weather conditions should be anticipated and planned for during earthwork. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavations, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

The site should be graded such that positive drainage (normally 2% minimum) is provided away from any structures. Where sidewalks or paving do not immediately adjoin the building, protective slopes of at least 5% for a minimum of 10 feet from the perimeter walls are recommended. Roof drains and downpours should also be directed away from the building. Open-graded stone is not recommended for use under sidewalks unless the stone is adequately drained to prevent collection of water under the walks.

The site should also be graded to avoid water flows, concentrations, or pools behind retaining walls, curbs or similar structures. When swales are designed at the top of the walls, proper line and slope should be considered to avoid any flow down behind walls. Special attention is needed for sources of storm water from slopes, building roofs, gutter downspouts and paved areas draining to one point.

Perforated plastic pipes should be placed on the backfilled side of the walls near the bottom and day-lighted. Six inches of open graded crushed rock wrapped with geo-textile fabric should be placed behind the walls up to a depth of two feet below the finished grade. As an alternative to the open graded crushed rock, a manufactured geo-composite sheet drain such as Mirafi G100N, Contech C-Drain, or equivalent, may be used in conjunction with the perforated pipe.

6.6 LANDSCAPING

Landscaping and irrigation should be limited adjacent to buildings and pavements to reduce the potential for large moisture changes. Trees and large bushes can develop intricate root systems that can draw moisture from the subgrade, resulting in shrinkage of the bearing material during dry periods of the year. Desiccation of bearing material below foundations may result in foundation settlement.

Landscaped areas near pavements and sidewalks should include a drainage system that prevents over saturation of the subgrade beneath asphalt and concrete surfaces. Drainage systems in irrigation areas should be incorporated into the storm drain system.

7 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

7.1 FOUNDATIONS RECOMMENDATIONS

Conventional spread and continuous wall footings are, generally, most economical when the existing soil conditions allow them to be founded at shallow depths on existing materials. Based on the materials encountered during this exploration, it is CFS Engineers' opinion that the planned structure can be supported by a shallow foundation system, such as spread and/or trench footings bearing in native clay soils.

Please note, approximately three (3) to six (6) feet of undocumented fill was encountered beneath the ground surface at the addition sites. Undocumented fill is any foreign material that was placed or dumped in an uncontrolled manner (i.e. no records of testing exist from the time of placement). Undocumented fill is inconsistent and unpredictable in nature, and it should not be used in support of any foundation systems. If encountered during construction, the foundations should be over excavated to native clay soils. Lean concrete can be utilized to return the over excavation depth to the planned bearing elevation. Undocumented fill is permitted beneath non load bearing floor slabs given it is thoroughly evaluated by CFS during construction by means of a proof roll outlined above. Please reference the following table for recommended design parameters.

Table 5: Shallow Foundation Design Parameters

DESIGN PARAMETER	RECOMMENDED VALUE	COMMENTS
Allowable Bearing Capacity (1) (shallow foundations)	1,500 psf	Evaluated based on field and laboratory testing results (1).
Recommended Bearing Material (2)	CLAY SOIL	Suitable bearing material required beneath entirety of foundation system (2). CFS anticipates over excavations of up to three (3) feet may be necessary to achieve a suitable bearing condition.
Anticipated Total Settlement	< 1-inch	Maximum
Anticipated Differential Settlement	< ¾ -inch	Maximum per 100 feet of linear footing
Minimum Recommended width	24 and 16 inches	Spread and trench, respectively
Minimum Recommended Depth	36-inches	Based on seasonal freeze-thaw cycles

(1) If over excavation of any footing is required to reach design bearing capacity, backfill of the footing should be done with lean concrete.
(2) A uniform bearing condition should exist beneath the entirety of the foundation system for a given structure. A representative of the Geotechnical Engineer should test the materials in the footing excavations to verify the material and design bearing pressure.

Footings should be suitably reinforced to reduce the effects of differential movement that may occur due to variations in the properties of the supporting soils. Top and bottom reinforcing steel is recommended

for continuous wall footings to reduce differential settlement due to possible varying bearing capacities of the existing fill soils.

Every effort should be made to keep the footing excavations dry as the soils will tend to soften when exposed to free water. Footing bottoms should be free of loose soil and concrete should be placed as soon as possible to prevent drying of the foundation soils.

7.2 SEISMIC ANALYSIS

The determination of the seismic class is based on ASCE Standard 7: Minimum Design Loads for Building and Other Structures. Based upon this information, the seismic properties of the soil were interpolated from the standard penetration test values. A Seismic Site Class "D" was determined for this site. In addition, there is no significant risk of liquefaction or mass movement of the on-site soils due to a seismic event.

7.3 SLAB ON GRADE RECOMMENDATIONS

In its current state, the overburden materials encountered during this exploration are considered unstable and unsuitable for direct support of the planned slab on grade. CFS recommends all concrete slabs on grade be supported by a minimum of 24-inches of Low Volume Change (LVC) material. LVC material should consist of lean clay (CL), KDOT AB3, crushed limestone screenings or equivalent. A low volume change material is defined as a material with a liquid limit less than 45 and a plasticity index less than 25. The subgrade can be constructed as outlined below.

1. Cut the subgrade to a minimum depth of 24-inches beneath the planned bottom of slab elevation. The exposed material at this depth should be moisture conditioned and re-compacted, as necessary, to pass a proof roll as specified in Section 6.1, "Site Preparation" of this report.

2. Twenty (20) inches of a compacted LVC material should be placed atop the exposed slab subgrade. The LVC should be placed in lifts no greater than 8-inches-thick (compacted thickness) and compacted to 95% of the maximum dry density as determined by ASTM 698. Limestone based LVC material should be compacted at a moisture content sufficient to achieve the desired compaction, and lean clay (CL) material should be compacted at a moisture content between -2 and +3% of optimum. Please note, if lean clay is utilized as LVC, CFS recommends it be capped with 6-inches of limestone based LVC to ease construction and protect the subgrade from excessive drying and wetting.

3. A 4-inch-thick layer of open graded stone (ASTM C33 or equivalent material) should be placed atop the 20-inches of compacted LVC material to return the subgrade to the original bottom of slab elevation. The open-graded stone will ease construction and provide a capillary break between the LVC and concrete slab.

Based on the materials encountered, 100 psi/in can be used as a modulus of subgrade reaction (k_s) for fat or lean clay soils. A subgrade reaction modulus value of 150 psi/in can be used for 20-inches of compacted granular fill such as KDOT AB3, MODOT Type 5 or equivalent.

Every floor slab should be evaluated to determine if a vapor retarder under the concrete floor is required. The slab designer should refer to ACI 302 and/or ACI 360 for procedures regarding the use and placement of a vapor retarder.

To reduce the effects of differential movement, slabs-on-grade should not be rigidly connected to columns, walls, or foundations unless it is designed to withstand the additional resultant forces. Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction. Expansion joints may be used to allow unrestrained vertical movement of the slabs. The floor slabs should be designed to have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage. CFS suggests joints be provided on a minimum spacing of twelve (12) feet on center. For additional recommendations refer to the ACI Design Manual. The requirements for the slab reinforcement should be established by the designer based on experience and the intended slab use.

7.4 LATERAL EARTH PRESSURES

Lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient. If the foundation walls are rigidly attached to the building and not free to rotate or deflect at the top, CFS recommends designing the walls for the *at-rest* earth pressure coefficient. Walls that are permitted to rotate and deflect at the top can be designed for the *active* lateral earth pressure condition. Horizontal loads acting on shallow foundations are resisted by friction along the foundation base and by *passive* pressure against the footing face that is perpendicular to the line of applied force.

It is recommended that all walls be backfilled with open graded stone (such as No. 57 as referenced in ASTM C33) extending to two (2) feet behind the wall for the entire height of the wall to within 12-inches of the surface to allow for proper drainage and relief of any hydrostatic pressure build-ups that may occur in the native clay. The use of stone to backfill behind the walls will expedite construction, reduce potential settlement between the wall and the floor slab and lower the pressure induced on the wall from the backfill thus potentially reducing the thickness of the walls.

Table 6: Earth Pressure and Friction Coefficients

MATERIAL	ACTIVE (K_a)	PASSIVE (K_p)	AT-REST (K_o)	ALLOWABLE BASE FRICTION	UNIT WEIGHT (pcf)
Open-graded crushed limestone	0.27	3.69	0.43	0.47	130-140
In-situ lean clay soils	0.40	2.5	0.68	0.32	120-125
In-situ fat clay soils	0.49	2.04	0.66	0.24	120-125
Lean clay – conditioned and compacted	0.32	3.12	0.48	0.35	120-125
Fat clay/Weathered Shale – conditioned and compacted	0.45	2.2	0.63	0.27	120-130
Limestone Bedrock	-	-	-	0.55	140-150

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading, or a sloping backfill. Nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied upon to provide some level of passive resistance should be placed in lifts not exceeding six (6) inches in thickness and compacted to a minimum density of 95% of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within +- 3% of the optimum moisture content. It is recommended that a representative of CFS should verify the compaction of any such materials relied upon to provide passive pressure.

The actual earth pressure on the walls will vary according to material types and backfill materials used and how the backfill is compacted. If the backfill conditions are different than the ones used above, CFS should be notified so the recommendations can be modified. The buildup of water behind a wall will increase the lateral pressure imposed on below-grade walls. Adequate drainage should be provided behind any below grade walls as described in this report. The walls should also be designed for appropriate surcharge pressures such as adjacent traffic, interior building floor slab loads, and construction equipment.

8 GENERAL COMMENTS

When the plans and specifications are complete, or if significant changes are made in the character or location of the proposed building, a consultation should be arranged to review the changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of Cook, Flatt & Strobel Engineers be engaged to test and evaluate the compaction of any additional fill materials and to test and evaluate the bearing value of the soils in the footing excavations.

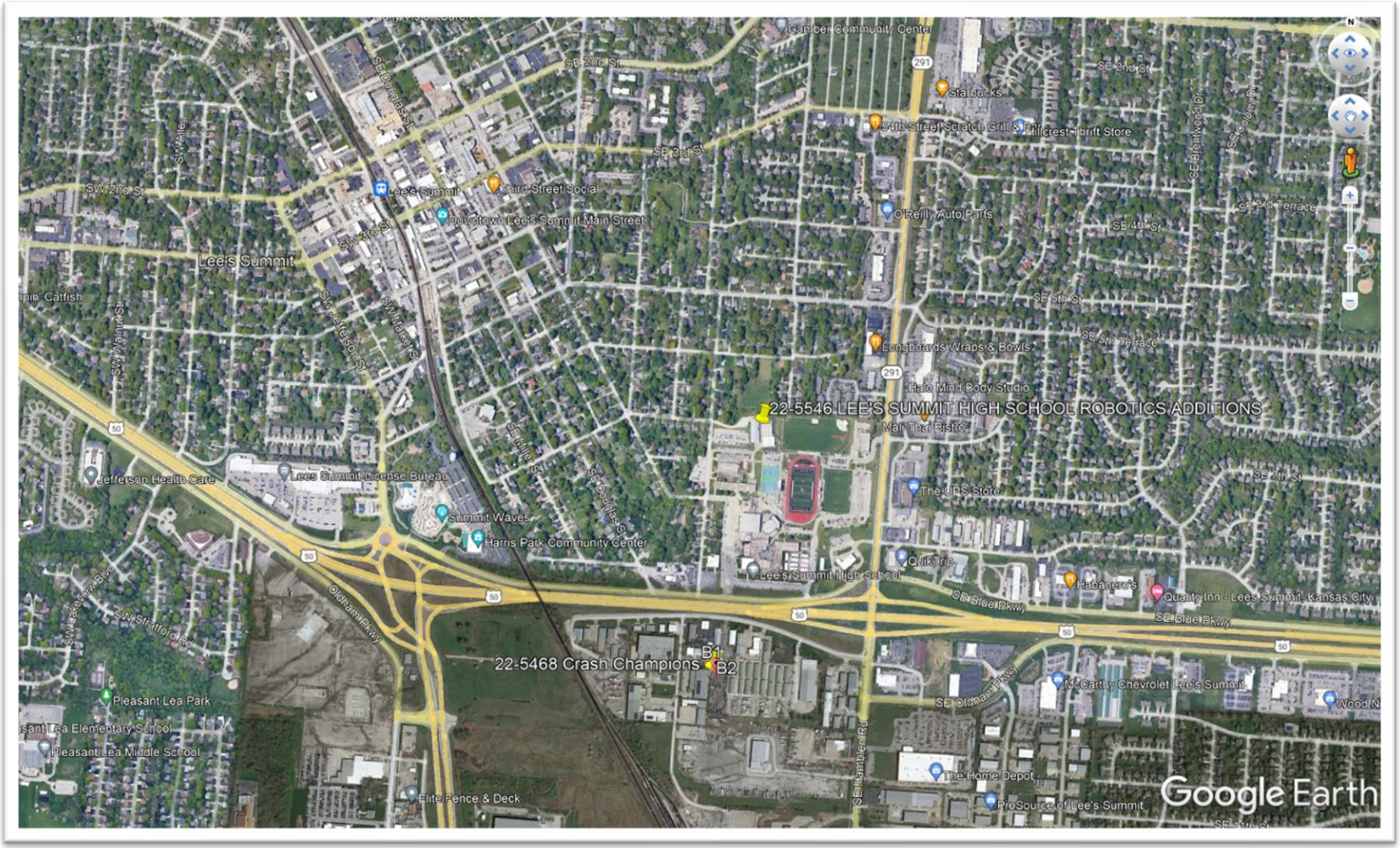
Respectfully submitted,

COOK, FLATT & STROBEL ENGINEERS, P.A.

Jacob Engler, P.E.
Geotechnical Engineer

Reviewed by: Adam McEachron, P.E.
Senior Geotechnical Engineer

Appendix A: Figures



CFS ENGINEERS

1100 W. Cambridge Circle Dr, Ste 700
Kansas City, Kansas 66103

Project:	**LEE'S SUMMIT HIGH SCHOOL ROBOTICS ADDITIONS**	Project #: 22-5546	Figure 1: **SITE LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 District		
Date:	8/23/2022		

CFS ENGINEERS

1100 W. Cambridge Circle Dr, Ste 700
Kansas City, Kansas 66103

Project:	**LEE'S SUMMIT HIGH SCHOOL ROBOTICS**	Project #: 22-5546	Figure 2: **BORING LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 District		
Date:	8/23/2022		

Appendix B: Boring Logs

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B1

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEES SUMMIT HIGH SCHOOL ROBOTICS BUILDING
PROJECT NUMBER 22-5546
PROJECT LOCATION Lee's Summit, MO
DATE STARTED 08/09/22 **COMPLETED** 08/09/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
▽ **AT TIME OF DRILLING** 18.50 ft
LOGGED BY BB **CHECKED BY** JE
AT END OF DRILLING --- Not Recorded
NOTES _____
AFTER DRILLING --- Not Recorded

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		6-inches of ASPHALT										
		LEAN CLAY, (CL) dark brown, moist, with gravel (FILL)	SPT 1	72	2-2-4 (6)	3.25		19.4	45	22	23	
		LEAN CLAY, (CL) dark grayish brown, moist, medium stiff	SPT 2	83	2-2-5 (7)	1.75		30.9				
5		(CL) brown and blueish gray below 6'	SPT 3	78	2-2-5 (7)	2		31.9				
		(CL) soft, gray and tan below 8'	SPT 4	83	2-2-2 (4)	1.5		28.8				
10												
		LEAN CLAY, SILTY, (CL) dark gray, moist, medium stiff	SPT 5	100	2-2-4 (6)	4.25		29.6				
15												
		▽	SPT 6	100	2-2-4 (6)	2		24.4				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B2

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEES SUMMIT HIGH SCHOOL ROBOTICS BUILDING
PROJECT NUMBER 22-5546
PROJECT LOCATION Lee's Summit, MO
DATE STARTED 08/09/22 **COMPLETED** 08/09/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
▽ **AT TIME OF DRILLING** 13.50 ft
LOGGED BY BB **CHECKED BY** JE
▼ **AT END OF DRILLING** 18.50 ft
NOTES _____
AFTER DRILLING --- Not Recorded

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		6-inches of ASPHALT										
		LEAN CLAY, (CL) blueish gray and brown, moist, medium stiff, (possible FILL)	SPT 1	72	2-2-4 (6)	3.75		23.9				
			SPT 2	72	2-3-4 (7)	2.25		24.9				
5												
		FAT CLAY, (CH) brown and blueish gray, moist to wet, soft	SPT 3	89	2-1-2 (3)	2.75		26.3				
			SPT 4	89	2-2-2 (4)	1.25		32.0				
10												
		▽ LEAN CLAY, SILTY, (CL) dark gray, moist, medium stiff	SPT 5	100	2-2-3 (5)	2.25		30.9				
15												
		▼	SPT 6	100	2-3-5 (8)	2		23.9				
20												

Bottom of borehole at 20.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B3

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEES SUMMIT HIGH SCHOOL ROBOTICS BUILDING
PROJECT NUMBER 22-5546
PROJECT LOCATION Lee's Summit, MO
DATE STARTED 08/09/22 **COMPLETED** 08/09/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY BB **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Waterline at 3'
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		6-inches of ASPHALT										
		LEAN CLAY, (CL) dark brown and black, moist, with gravel (FILL - utility trench)	SPT 1	50	2-2-3 (5)							

Bottom of borehole at 3.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B3-Offset

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEES SUMMIT HIGH SCHOOL ROBOTICS BUILDING
PROJECT NUMBER 22-5546
PROJECT LOCATION Lee's Summit, MO
DATE STARTED 08/09/22 **COMPLETED** 08/09/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY BB **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Offset 80 inches from waterline
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		6-inches of ASPHALT										
		LEAN CLAY, (CL) dark brown and brown, moist, with gravel (FILL)	SPT 1	72	2-4-5 (9)	4.25		21.0				
			SPT 2	67	3-4-5 (9)	2.5		27.8				
5		FAT CLAY, (CH) brownish olive and gray, moist, stiff	SPT 3	89	3-4-6 (10)	1.75		31.2				
		(CH) grayish brown with iron nodules below 8'	SPT 4	100	2-3-5 (8)	3		23.7				
10		SHALE, unweathered, tannish olive	SPT 5	86	33-50/1"	2.5		17.6				
15			SPT 6	86	33-50/1"	2.25		13.9				

Refusal at 17.7 feet.
Bottom of borehole at 17.7 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B4

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEES SUMMIT HIGH SCHOOL ROBOTICS BUILDING
PROJECT NUMBER 22-5546
PROJECT LOCATION Lee's Summit, MO
DATE STARTED 08/09/22 **COMPLETED** 08/09/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY BB **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES terminated at 6'
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0		LEAN CLAY, (CL) brown, dry, stiff to medium stiff, with gravel, encountered possible utility line (Possible Utility Trench)										
			SPT 1	44	2-3-5 (8)	4.5+		16.7				
5			SPT 2	22	2-1-2 (3)	4.5+		13.2				
		Bottom of borehole at 6.0 feet.										

GEOTECHNICAL EXPLORATION AND SUBGRADE RECOMMENDATIONS

LEE'S SUMMIT WEST HIGH SCHOOL ROBOTICS BUIDLING

Lee's Summit, Missouri

CFS Project No. 22-5547

Prepared For

Lee's Summit R7 District
901 NE Douglas Street
Lee's Summit, Missouri 64086

July 28, 2022

Prepared by:
Cook, Flatt & Strobel Engineers, P.A.
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103
913.627.9040

One Vision. One Team. One Call.

SYNOPSIS

A subsurface exploration and an evaluation were performed at the planned Lee's Summit West High School Robotics Building project site located in Lee's Summit, Missouri to provide geotechnical engineering related recommendations for design and construction of the proposed project.

Exploratory soil borings have been drilled and a laboratory testing program was conducted on selected soil samples. The data has been analyzed based upon the project information provided by the project team.

The results of the exploration and analysis indicate that conventional spread and continuous wall footings appear to be a suitable foundation system for support of the proposed structure. Please note, CFS anticipates some limestone bedrock excavation will be necessary in the southeast building corner to achieve a uniform bearing condition on shale bedrock. This may require the use of breakers which can increase the cost of excavation.

Detailed analysis of subsurface conditions, any alternate foundation types, and pertinent design recommendations are included, herein.

Groundwater conditions are not expected to cause any major difficulties. These conditions will be further discussed in the report. Please note, groundwater levels should be expected to fluctuate based on seasonal changes and precipitation events.

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Appendix A: Figures

Figure 1 – Project Location

Figure 2 – Boring Location Plan

Appendix B: Boring Logs

Geotechnical Exploration
and Foundation Recommendations

LEE'S SUMMIT WEST HIGH SCHOOL ROBOTICS BUILDING
LEE'S SUMMIT, MISSOURI

Project Number: 22-5547
July 28, 2022

1 INTRODUCTION

1.1 PURPOSE

The purpose of this geotechnical exploration was to evaluate the underlying materials at the proposed Lee's Summit West High School Robotics Building project site, and based upon this information, provide geotechnical engineering related recommendations for design and construction of the planned project. This exploration was performed in accordance with the requirements outlined by the project team and the Lee's Summit R-7 School district's request for proposal (RFP) number R19/20-04 titled "Geotechnical 7 Construction Testing Services" and dated March 17, 2020.

This report includes geotechnical recommendations and considerations pertaining to site development, foundation support, and concrete slab on grade construction. Also, included in this report are earthwork, construction and drainage considerations associated with the proposed project.

1.2 SCOPE OF SERVICES

This exploration and analysis included an engineering reconnaissance of the planned site, a subsurface exploration as outlined below, a field and laboratory testing program, and an engineering analysis and evaluation of the subsurface materials.

The scope of services did not include any environmental assessment for wetlands or hazardous materials in the soil, surface water, groundwater, air or surrounding area. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items is strictly for the information of the client.

1.3 GENERAL

The general subsurface conditions used in this analysis are based upon an interpolation of the subsurface data between the borings; varying conditions may be encountered between boring locations. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the Geotechnical Engineer.

The recommendations submitted for the proposed structure are based on the available soil information and the preliminary design details. Any revision in the plans for the proposed structure from those described in this report should be brought to the attention of the Geotechnical Engineer to determine if changes in the foundation recommendations are required.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, and professional advice contained, herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that the Geotechnical Engineer be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and foundation recommendations are properly interpreted and implemented.

2 PROJECT DESCRIPTION

It is understood that the planned project comprises the new construction of a robotics and GiC facility on the southeast side of the existing Lee's Summit West High School. This facility will consist of three (3) individual structures, all independent of each other and the existing high school. CFS understands they will be single story buildings with concrete slab on grade construction. The proposed finish floor elevations were not available at the time of this report, however, CFS anticipates they will be similar to that of the existing grade. Foundation loads are expected to be on the order of 100 kips for column footings and two (2) to three (3) kips per linear foot for continuous wall footings.

CFS anticipates minimal cut and fill, less than three (3) feet plus or minus, will be necessary to achieve the desired construction grade. If any changes to the project occur, please notify CFS to allow for review of these changes and, if necessary, amend this report.

2.1 SITE LOCATION & SURFACE CONDITIONS

Lee's Summit West High School is located at 2800 SW Ward Road in Lee's Summit, Missouri. The project site is the southeast side of the existing school. It is bound by the existing school to the northwest and north, an open grass area to the east, and drive lanes to the south and west.

The area of the project site adjacent to the existing school is, relatively, level and grass covered. However, the existing grade does slope upward to the east and southeast starting at approximately 65 feet away from the school. Boring B8 encountered a limestone shelf in this slope that resides in the east-most corner of the largest structure. Previously, two (2) classroom trailers were at the project site, as well.

2.2 SITE GEOLOGY

Soils in the greater Kansas City area are generally residual soils, alluvial deposits, or till. Residual soils formed as a result of weathering of bedrock, or by weathering of sediments that were transported by water, ice, wind or a combination of these. Regional soils derived from shale, limestone, and loess have high shrink-swell potentials. Major alluvial deposits occur along the Missouri and Kansas rivers and their tributaries. These consist of clay, sand and gravel sized sediments. Northern parts of the city were glaciated during the early Pleistocene time resulting in till deposits. Surface bedrock in northeastern Kansas and northwestern Missouri generally consist of limestone and shale (with sandstone found in prehistoric channels) arranged in nearly horizontal beds or layers that can be followed continuously over long distances. These bedrocks are part of the Pennsylvanian bedrock system.

3 SUBSURFACE EXPLORATION

Based on the project information as outlined above, CFS Engineers conducted a field exploration to determine the underlying materials at the proposed project site and to establish their engineering characteristics.

3.1 SCOPE OF WORK

This geotechnical exploration consisted of eight (8) borings with a planned depth of 20 feet beneath existing site grade within the footprint of the planned structure. The borings were drilled to their refusal on shale or limestone bedrock. The boring locations can be seen on the Boring Location Plan which is included in Appendix A.

The boring locations were determined in the field using measurements from existing landmarks and should be considered accurate only to the degree implied. The locations were established by Cook, Flatt & Strobel Engineers.

Boring logs representing the materials encountered in the borings are included in Appendix B. The boring logs represent CFS Engineers' interpretation of the field logs combined with laboratory observations and testing of the samples. The stratification boundaries indicated on the boring logs were based on field observations, an extrapolation of information obtained by examining samples from the borings, and comparisons of soils and/or bedrock types with similar engineering characteristic. As such, the boundaries between subsurface strata should be expected to vary from the logs to some extent.

The depth to groundwater, if encountered, was recorded in each test boring during drilling and can be seen in Section 3.5, Groundwater Conditions. After completion of drilling, sampling, and field testing, the excavations were backfilled with auger cuttings.

3.2 DRILLING AND SAMPLING PROCEDURES

The auger borings were drilled using a truck mounted Dietrich D50 drill rig with a rotary head. 3.25-inch solid-stem augers were used to drill the holes. During drilling, field logs were created and maintained by CFS personnel to catalog the materials encountered.

Representative samples were obtained during drilling using split-barrel sampling procedures in general accordance with the procedures for "Standard Test Methods for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM D 1586).

Upon completion of drilling, the samples were then sealed and returned to CFS's laboratory for further examination, classification, and testing. The samples recovered were identified, classified, and evaluated by a Geotechnical Engineer.

3.3 FIELD TESTS AND MEASUREMENTS

During the soil boring procedure, Standard Penetration Tests (SPT) were performed at pre-determined intervals to obtain the standard penetration value of the soil as outlined in the ASTM D1586 test method. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer falling 30

inches, required to advance the split-barrel sampler one foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive increments of six inches penetration. The "N" value is then obtained by adding the second and third incremental numbers. The results of the standard penetration test are shown on the Boring Logs and indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

The Standard Penetration Test (SPT) was also used to evaluate the consistency of the in-situ materials. The N-values for the site's materials were found to range from nine (9) to 50+ blows/foot.

3.4 SUBSURFACE CONDITIONS

The materials encountered in the test borings have been visually classified according to the Unified Soil Classification System (USCS). Specific subsurface conditions encountered—including field tests, lab tests, and water level observations—at the boring locations are also presented on the individual boring logs found in Appendix B of this report. The following table presents a general summary of the major strata encountered during this subsurface exploration.

T*able 1: General Subsurface Conditions*

STRATUM	MATERIAL	DEPTH TO TOP OF STRATUM (FT)	DEPTH TO BOTTOM OF STRATUM (FT)	MEASURED N-VALUES	COMMENTS
1	TOPSOIL	0.0	0.5	NA	Dark brown with roots. Grass at surface
2	LIMESTONE	2.0	4.5	50+	Encountered in boring B8 which was about 3 feet higher in elevation than the surrounding borings.
3	SHALE	0.5	BOTTOM	9 to 50+	Gray and moderately weathered to unweathered.

Note: the boundaries between subsurface strata should be expected to vary from this table and the logs to some extent.

3.5 GROUNDWATER CONDITIONS

Groundwater was not encountered in the borings at the time of the investigation. Please note, the reported groundwater levels reflect the conditions observed at the time the borings were drilled. Groundwater levels should be expected to fluctuate with changes in grading, precipitation changes and seasonal changes. The water levels included in this report do not indicate a permanent groundwater condition. Additionally, the materials encountered during this exploration are, generally, low permeable soils.

4 LABORATORY TESTING

Upon completion of drilling, the samples were returned to CFS's laboratory located in Kansas City, Kansas for laboratory testing. A supplemental laboratory testing program was conducted to evaluate additional engineering characteristics of the in-situ soils necessary in analyzing the behavior of the support systems for the proposed building.

The laboratory testing program included the following tests:

- Supplementary visual classification (ASTM D2488) of all samples,
- Water content (ASTM D2216) of all samples, and
- Atterberg limit tests (ASTM D4318) on a selected sample.

The results of the laboratory testing program can be seen in on the boring logs in Appendix B. The Atterberg limits can be seen in the following table.

Table 2: Atterberg Limits Results

Boring ID	Sample #	Moisture Content (%)	Atterberg Limits			USCS Classification
			Liquid Limit	Plastic limit	Plasticity Index	
B6	SPT-1	14	43	23	20	SHALE

5 GEOTECHNICAL CONCERNS

The following geotechnical concerns are based upon the subsurface materials encountered during this exploration and CFS's understanding of the project as described in Section 2, "Project Description" of this report. If any changes to the planned structure's location, loading or elevations occur, CFS must be allowed to review these changes, and if necessary, issue amendments to this report and its recommendations.

1. *Bedrock Excavation*: Shallow shale bedrock was encountered at a depth of approximately one (1) foot beneath existing grade across the majority of the project site. CFS anticipates approximately three (3) to five (5) feet of shale excavation may be necessary for foundation and utility excavations. Additionally, please note that Boring B8 encountered a limestone shelf in the slope that resides in the east-most corner of the largest structure. CFS anticipates this slope will be cut down approximately three (3) feet to achieve the desired construction grade, thus some limestone excavation will be necessary in this area. Also, to achieve a uniform bearing condition, the planned foundations in this corner will need to penetrate the limestone and bear on the underlying shale bedrock encountered in the other borings. Shale and limestone excavation may require the use of hydraulic breakers which generally increases the cost of excavation.

2. *Possible Perched Water*: Although groundwater was not encountered during this exploration, it is common for perched water to travel along restrictive bedrock layers such as the limestone bedrock encountered in the slope at the eastmost corner of the project site. Additionally, please note that

this exploration occurred during the dry season. Depending on the time of construction, the contractor should plan for water seepage out of this slope once the limestone is excavated.

3. *Expansive Clay Soils*: Expansive shales were encountered during this exploration. The on-site materials are NOT suitable for direct support of concrete slabs and concrete/foundation wall backfill. It is recommended that all walls be backfilled with open graded stone (such as No. 57 as referenced in ASTM C33) extending two (2) feet behind the wall for the entire height of the wall to within 12-inches of the surface to allow for proper drainage and relief of any hydrostatic pressure build-ups that may occur in the native fat clay. All slabs on grade should be supported by a minimum 24-in-thick mat of low volume change material (LVC) constructed in accordance with Section 7.3, "Slab on Grade Recommendations" of this report.

6 EARTHWORK & SITE DEVELOPMENT

6.1 SITE PREPARATION

Prior to filling, the grass and topsoil should be stripped from all structural areas and be stockpiled for later use in landscape areas, or it should be wasted. Any trees and shrubs should be properly removed including the entirety of the root ball and root systems. The upper 12-inches of the subgrade should be moisture conditioned and recompacted, as necessary, to provide a stable subgrade upon which to begin placement of engineered fill.

Upon completion of stripping and prior to filling, the newly exposed subgrade should be evaluated by a qualified professional for stability by means of proof rolling. The proof roll should be conducted using a fully loaded, tandem axle dump truck weighing in excess of 25 tons. Any soft or unsuitable areas identified during the proof roll should be corrected by means of additional moisture conditioning and recompacting, or removal and replacement with an acceptable material.

Additionally, any undocumented fill encountered during construction should be completely removed from beneath the planned foundations. Please note, the fill encountered during this exploration was at the surface and CFS anticipates foundations will naturally penetrate this material. Undocumented fill is any foreign material that was placed or dumped in an uncontrolled manner (i.e. no records of testing exist from the time of placement). Undocumented fill is inconsistent and unpredictable in nature, and it should not be used in support of any foundation systems. Undocumented fill is permitted beneath non load bearing floor slabs given it is thoroughly evaluated by CFS during construction by means of a proof roll outlined above.

6.2 FILL MATERIALS

All general and structural fill should be free of debris and defined by ASTM 2487 as CH, CL, ML, GW, GP, SM, SW, SC, and SP. The onsite soils tend to meet this requirement; however, please note that CH (fat clay) classification materials should NOT be used as structural fill within two (2) feet of the finished grade supporting the building slab and within ten (10) feet laterally outside of the building footprint. Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement without being treated with cement as outlined later in this report.

The on-site topsoil contains organic material and is unsuitable for use as structural fill. Unsuitable materials are those defined by ASTM 2487 as MH, OL, OH, and PT.

6.3 ENGINEERED FILL PLACEMENT

For the purpose of this report, engineered fill means fill placed in controlled layers and compacted and tested according to accepted geotechnical engineering practices to ensure that it meets the required specifications. Structural fill refers to any engineered fill placed within the footprint of the planned structures. Engineered fill materials should be free of organic matter. During placement, engineered fill materials should be within the specified moisture contents and compacted to the specified densities given below in Tables two (2) and three (3). Maximum dry density and optimum moisture content should be determined by the Standard Proctor test (ASTM D 698).

Fill should be placed in six (6) inch lifts (compacted thickness) in mass fill areas, and as needed to obtain the proper compaction in utility trenches and behind walls. Structural fill should extend a minimum of two (2) feet beyond any structure lines. *Additionally, where slopes exist, engineered fill must be properly benched into the existing materials.*

Table 3: Recommended Moisture Ranges

ENGINEERED FILL MATERIAL	MAXIMUM BELOW OPTIMUM	MAXIMUM ABOVE OPTIMUM
Lean Clay (CL)	-2%	+3%
Fat Clay (CH)	0%	+4%
Compacted Base Rock (i.e. MODOT Type 5, AB3 or equivalent)	NA	NA

Table 4: Compaction Requirements & Testing Frequency

LOCATION OR AREA	REQUIED COMPACTION (%) (ASTM D 698, DRY DENSITY)	TESTING FREQUENCY 3 PER LIFT PER …
Building Walkways	95%	20,000 sf
Retaining Walls	95%	1,000 sf
Trenches	95%	150 lf
Lawn or Unimproved Areas	92%	20,000 sf
Structural Fill (i.e., building and pavement subgrades)	95%	10,000 sf
Out-Parcels	95%	20,000 sf

A representative of the Geotechnical Engineer should monitor filling operations on a full-time basis. A sufficient number of density tests should be taken to verify that the specified compaction is obtained. See Table 3 above for required testing frequency.

6.4 EXCAVATIONS & TRENCHES

All temporary slopes and excavations should conform to Occupational Safety and Health Administration (OSHA) Standards for the Construction Industry (29 CFR Part 1926, Subpart P). Excavations at this site

are *expected* to be made in "Type B" clayey soil. Soil types should be verified in the field by a competent individual.

All excavations should be kept dry during subgrade preparation. Storm water runoff should be controlled and removed to prevent severe erosion of the subgrade and eliminate free standing water. Subgrade that has been rendered unsuitable from erosion or excessive wetting should be removed and replaced with controlled fill. Excavations through the very hard limestone and shale bedrocks will likely be necessary. The Boring Logs (Appendix B) and the Boring Location Plan (Figure 2, Appendix A) should be consulted in estimating the amount of rock to be excavated.

Trenches should be excavated so that pipes and culverts can be laid straight at uniform grade between the terminal elevations. Trench width should provide adequate working space and sidewall clearances. Trench subgrade should be removed and replaced with controlled fill if found to be wet, soft, loose, or frozen. Trench sub-grades should be compacted above 95% of the maximum dry density in accordance with ASTM D 698 at moisture contents between -3% to +3% of the optimum moisture content.

Granular bedding materials for pipes, such as well-graded sand or gravel, may be used provided that the bottom of the trench is graded so that water flows away from the structure.

Bedding material should be graded to provide a continuous support beneath all points of the pipe and joints. Embedment material should be deposited and compacted uniformly and simultaneous on each side of the pipe to prevent lateral displacement. Compacted control fill material will be required for the full depth of the trench above the embedment material except in area landscape area with the compaction may be reduced to 90% Standard Proctor ASTM D 698. No backfill should be deposited or compacted in standing water.

Permanent slopes greater than 3 horizontals to 1 vertical should not be used unless additional testing and slope analysis is performed.

6.5 DRAINAGE AND DEWATERING

Normal seasonal weather conditions should be anticipated and planned for during earthwork. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

The site should be graded such that positive drainage (normally 2% minimum) is provided away from any structures. Where sidewalks or paving do not immediately adjoin the building, protective slopes of at least 5% for a minimum of 10 feet from the perimeter walls are recommended. Roof drains and downpours should also be directed away from the building. Open-graded stone is not recommended

for use under sidewalks unless the stone is adequately drained to prevent collection of water under the walks.

The site should also be graded to avoid water flows, concentrations, or pools behind retaining walls, curbs or similar structures. When swales are designed at the top of the walls, proper line and slope should be considered to avoid any flow down behind walls. Special attention is needed for sources of storm water from slopes, building roofs, gutter downspouts and paved areas draining to one point.

Perforated plastic pipes should be placed on the backfilled side of the walls near the bottom and day-lighted. Six inches of open graded crushed rock wrapped with geo-textile fabric should be placed behind the walls up to a depth of two feet below the finished grade. As an alternative to the open graded crushed rock, a manufactured geo-composite sheet drain such as Mirafi G100N, Contech C-Drain, or equivalent, may be used in conjunction with the perforated pipe.

6.6 LANDSCAPING

Landscaping and irrigation should be limited adjacent to buildings and pavements to reduce the potential for large moisture changes. Trees and large bushes can develop intricate root systems that can draw moisture from the subgrade, resulting in shrinkage of the bearing material during dry periods of the year. Desiccation of bearing material below foundations may result in foundation settlement.

Landscaped areas near pavements and sidewalks should include a drainage system that prevents over saturation of the subgrade beneath asphalt and concrete surfaces. Drainage systems in irrigation areas should be incorporated into the storm drain system.

7 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

7.1 FOUNDATIONS RECOMMENDATIONS

Conventional spread and continuous wall footings are, generally, most economical when the existing soil conditions allow them to be founded at shallow depths on existing materials. Based on the materials encountered during this exploration, it is CFS Engineers' opinion that the planned structure can be supported by a shallow foundation system, such as spread and/or trench footings bearing in shale bedrock.

Please note, shale and limestone bedrock excavation is anticipated which may require the use of hydraulic breakers. Additionally, some over excavation of limestone bedrock may be necessary in the eastmost corner of the larger building to achieve a uniform bearing condition on shale bedrock. CFS does not anticipated over excavation to exceed three (3) feet. Please reference the following table for recommended design parameters.

Table 5: Shallow Foundation Design Parameters

DESIGN PARAMETER	RECOMMENDED VALUE	COMMENTS
Allowable Bearing Capacity (1) (shallow foundations)	3,000 psf	Evaluated based on field and laboratory testing results (1).
Recommended Bearing Material (2)	SHALE	Suitable bearing material required beneath entirety of foundation system (2).
Anticipated Total Settlement	< 1-inch	Maximum
Anticipated Differential Settlement	< ¾ -inch	Maximum per 100 feet of linear footing
Minimum Recommended width	24 and 16 inches	Spread and trench, respectively
Minimum Recommended Depth	36-inches	Based on seasonal freeze-thaw cycles

(1) If over excavation of any footing is required to reach design bearing capacity, backfill of the footing should be done with lean concrete.
(2) A uniform bearing condition should exist beneath the entirety of the foundation system for a given structure. A representative of the Geotechnical Engineer should test the materials in the footing excavations to verify the material and design bearing pressure.

If over excavation of footings becomes necessary to achieve the desired bearing pressure or a uniform bearing condition, backfill of the footing should be done with lean concrete. Footings should be suitably reinforced to reduce the effects of differential movement that may occur due to variations in the properties of the supporting soils. Top and bottom reinforcing steel is recommended for continuous wall footings to reduce differential settlement due to possible varying bearing capacities of the existing fill soils.

Every effort should be made to keep the footing excavations dry as the soils will tend to soften when exposed to free water. Footing bottoms should be free of loose soil and concrete should be placed as soon as possible to prevent drying of the foundation soils.

7.2 SEISMIC ANALYSIS

The determination of the seismic class is based on ASCE Standard 7: Minimum Design Loads for Building and Other Structures. Based upon this information, the seismic properties of the soil were interpolated from the standard penetration test values. A Seismic Site Class "D" was determined for this site. In addition, there is no significant risk of liquefaction or mass movement of the on-site soils due to a seismic event.

7.3 SLAB ON GRADE RECOMMENDATIONS

In its current state, the overburden materials (i.e., Shale) encountered during this exploration are unsuitable for direct support of the planned slab on grade. CFS recommends all concrete slabs on grade be supported by a minimum of 24-inches of Low Volume Change (LVC) material. LVC material should consist of lean clay (CL), KDOT AB3, crushed limestone screenings or equivalent. A low volume change

material is defined as a material with a liquid limit less than 45 and a plasticity index less than 25. The subgrade can be constructed as outlined below.

1. Cut the subgrade to a minimum depth of 24-inches beneath the planned bottom of slab elevation. The exposed material at this depth should be moisture conditioned and re-compacted, as necessary, to pass a proof roll as specified in Section 6.1, "Site Preparation" of this report.

2. Twenty (20) inches of a compacted LVC material should be placed atop the exposed slab subgrade. The LVC should be placed in lifts no greater than 8-inches-thick (compacted thickness) and compacted to 95% of the maximum dry density as determined by ASTM 698. Limestone based LVC material should be compacted at a moisture content sufficient to achieve the desired compaction, and lean clay (CL) material should be compacted at a moisture content between 0 and +4% of optimum. Please note, if lean clay is utilized as LVC, CFS recommends it be capped with 6-inches of limestone based LVC to ease construction and protect the subgrade from excessive drying and wetting.

3. A 4-inch-thick layer of open graded stone (ASTM C33 or equivalent material) should be placed atop the 20-inches of compacted LVC material to return the subgrade to the original bottom of slab elevation. The open-graded stone will ease construction and provide a capillary break between the LVC and concrete slab.

Based on the materials encountered, 100 psi/in can be used as a modulus of subgrade reaction (k_s) for fat or lean clay soils. A subgrade reaction modulus value of 150 psi/in can be used for 20-inches of compacted granular fill such as KDOT AB3, MODOT Type 5 or equivalent.

Every floor slab should be evaluated to determine if a vapor retarder under the concrete floor is required. The slab designer should refer to ACI 302 and/or ACI 360 for procedures regarding the use and placement of a vapor retarder.

To reduce the effects of differential movement, slabs-on-grade should not be rigidly connected to columns, walls, or foundations unless it is designed to withstand the additional resultant forces. Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction. Expansion joints may be used to allow unrestrained vertical movement of the slabs. The floor slabs should be designed to have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage. CFS suggests joints be provided on a minimum spacing of twelve (12) feet on center. For additional recommendations refer to the ACI Design Manual. The requirements for the slab reinforcement should be established by the designer based on experience and the intended slab use.

7.4 LATERAL EARTH PRESSURES

Lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient. If the foundation walls are rigidly attached to the building and not free to rotate or deflect at the top, CFS recommends designing the walls for the *at-rest* earth pressure coefficient. Walls that are permitted to rotate and deflect at the top can be designed for the *active* lateral earth pressure condition. Horizontal loads acting on shallow foundations are resisted by friction

along the foundation base and by *passive* pressure against the footing face that is perpendicular to the line of applied force.

It is recommended that all walls be backfilled with open graded stone (such as No. 57 as referenced in ASTM C33) extending to two (2) feet behind the wall for the entire height of the wall to within 12-inches of the surface to allow for proper drainage and relief of any hydrostatic pressure build-ups that may occur in the native clay. The use of stone to backfill behind the walls will expedite construction, reduce potential settlement between the wall and the floor slab and lower the pressure induced on the wall from the backfill thus potentially reducing the thickness of the walls.

Table 6: Earth Pressure and Friction Coefficients

MATERIAL	ACTIVE (K_a)	PASSIVE (K_p)	AT-REST (K_o)	ALLOWABLE BASE FRICTION	UNIT WEIGHT (pcf)
Open-graded crushed limestone	0.27	3.69	0.43	0.47	130-140
In-situ lean clay soils	0.40	2.5	0.68	0.32	120-125
In-situ fat clay soils	0.49	2.04	0.66	0.24	120-125
Lean clay – conditioned and compacted	0.32	3.12	0.48	0.35	120-125
Fat clay/Weathered Shale – conditioned and compacted	0.45	2.2	0.63	0.27	120-130
Limestone Bedrock	-	-	-	0.55	140-150

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading, or a sloping backfill. Nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied upon to provide some level of passive resistance should be placed in lifts not exceeding six (6) inches in thickness and compacted to a minimum density of 95% of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within +- 3% of the optimum moisture content. It is recommended that a representative of CFS should verify the compaction of any such materials relied upon to provide passive pressure.

The actual earth pressure on the walls will vary according to material types and backfill materials used and how the backfill is compacted. If the backfill conditions are different than the ones used above, CFS should be notified so the recommendations can be modified. The buildup of water behind a wall will increase the lateral pressure imposed on below-grade walls. Adequate drainage should be provided behind any below grade walls as described in this report. The walls should also be designed for appropriate surcharge pressures such as adjacent traffic, interior building floor slab loads, and construction equipment.

8 GENERAL COMMENTS

When the plans and specifications are complete, or if significant changes are made in the character or location of the proposed building, a consultation should be arranged to review the changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of Cook, Flatt & Strobel Engineers be engaged to test and evaluate the compaction of any additional fill materials and to test and evaluate the bearing value of the soils in the footing excavations.

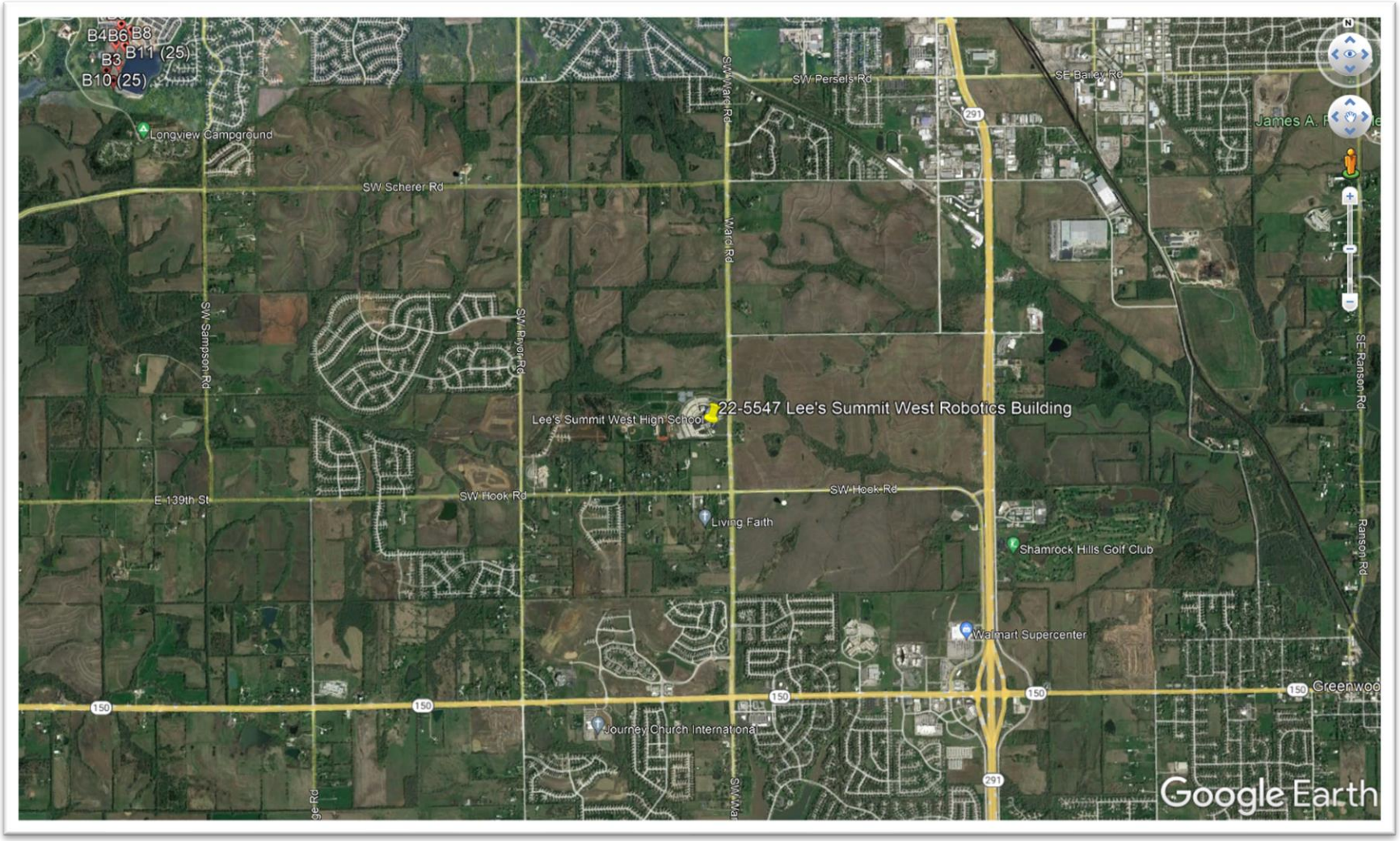
Respectfully submitted,

COOK, FLATT & STROBEL ENGINEERS, P.A.

Jacob Engler, P.E.
Geotechnical Engineer

Reviewed by: Adam McEachron, P.E.
Senior Geotechnical Engineer

Appendix A: Figures



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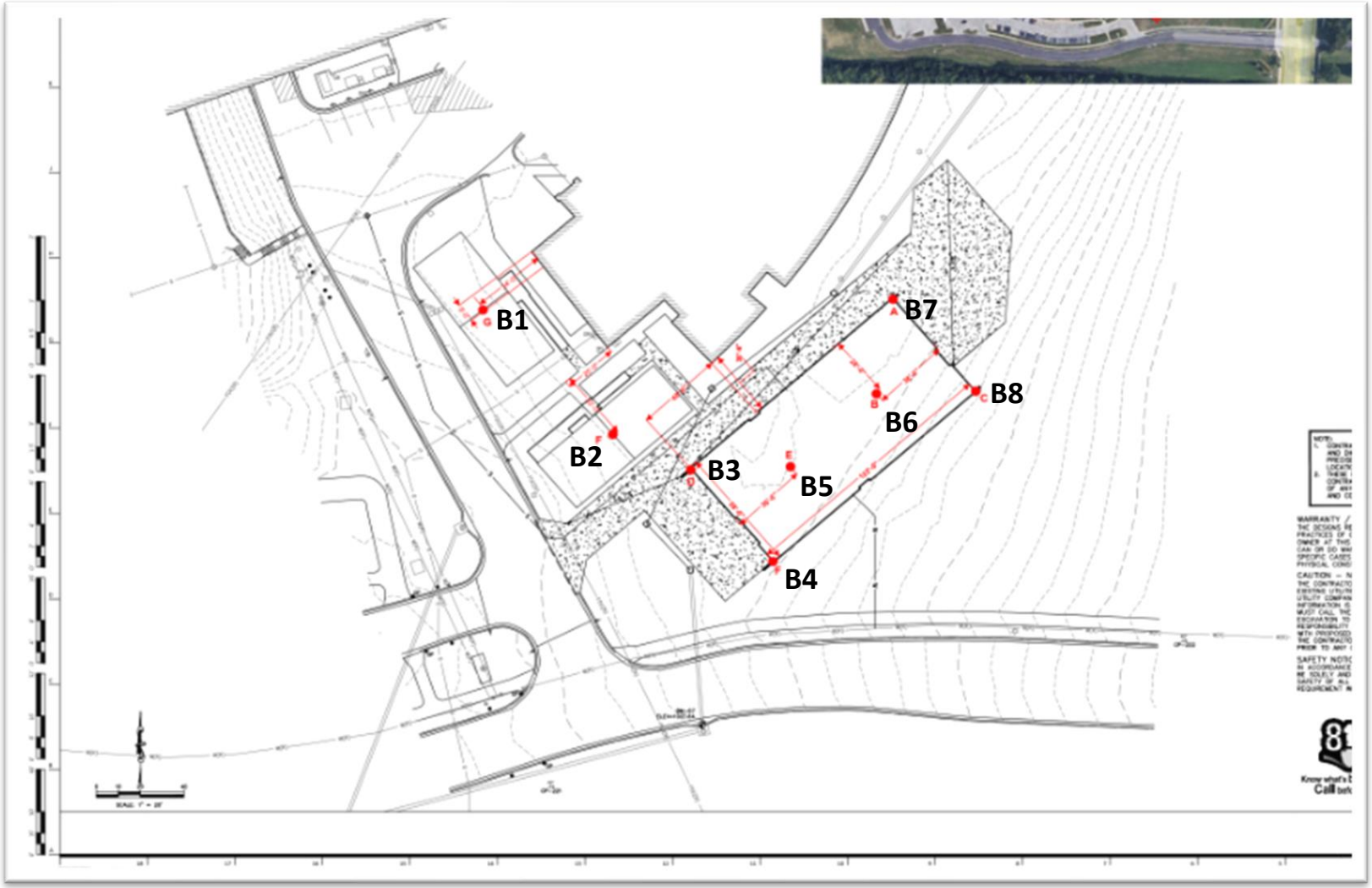
Project: **LEE'S SUMMIT WEST HIGH SCHOOL ROBOTICS BUILDING**		Project #: 22-5547	Figure 1: **SITE LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 District		
Date:	7/28/2022		



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Project: **LEE'S SUMMIT WEST HIGH SCHOOL ROBOTICS**		Project #: 22-5547	Figure 2: **BORING LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 District		
Date:	7/28/2022		

Appendix B: Boring Logs

CFS Engineers, Inc
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Kansas City, Kansas 66103

BORING NUMBER B1

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		SHALE, moderately weathered, brown										
		Unweathered, and gray below 1.5'	SPT 1	100	6-17-22 (39)	4.5		15.4				
2.5												
			SPT 2	100	13-16-50/4"	3		9.7				
5.0												
		Refusal at 6.1 feet. Bottom of borehole at 6.1 feet.	SPT 3	100	50/1"	2		9.6				

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BORING NUMBER B2

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		SHALE, moderately weathered, brown, with topsoil										
		Unweathered, and gray below 1'	SPT 1	100	12-50/5"	4.5		11.5	39	21	18	
2.5			SPT 2	100	50/5"	1.5		8.8				

Refusal at 3.9 feet.
Bottom of borehole at 3.9 feet.

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BORING NUMBER B3

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		LEAN CLAY, (CL) brown and dark brown, with gravel, Shaley (FILL)										
		SHALE, moderately weathered to unweathered, gray	SPT 1	100	5-12-18 (30)	4		14.6				
2.5												
			SPT 2	100	22-32-50/4"	4.5		12.8				
5.0												
			SPT 3	100	50/5"	4.5		11.9				

Refusal at 6.4 feet.
Bottom of borehole at 6.4 feet.

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BORING NUMBER B4

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		LEAN CLAY, (CL) dark brown, with vegetation at surface (TOPSOIL)										
		LIMESTONE, highly weathered, fractured										
		SHALE, highly weathered, gray and tan, with highly weathered limestone fragments at interface	SPT 1	67	2-5-4 (9)	4.5		19.7				
2.5		Unweathered, and gray below 3'										
			SPT 2	100	13-24-40 (64)	4		16.8				
5.0												
			SPT 3	33	21-50/3"	0		10.2				
7.5												
			SPT 4	100	50/5"	0		9.2				
10.0												
12.5			5	100	50/1"	0		7.3				

Refusal at 14.0 feet.
Bottom of borehole at 14.0 feet.

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BORING NUMBER B5

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		LEAN CLAY, (CL) dark brown, with vegetation at surface (TOPSOIL)										
		SHALE, moderately weathered, gray and tan										
		Unweathered, and gray below 1.5'	SPT 1	78	4-12-19 (31)	4.5		26.3				
2.5												
			SPT 2	100	12-17-20 (37)	4.5		11.6				
5.0												
			SPT 3	100	50/5"	0		9.1				
7.5												
			SPT 4	100	50/2"	1.5		10.7				

Refusal at 8.7 feet.
Bottom of borehole at 8.7 feet.

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BORING NUMBER B6

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		LEAN CLAY, (CL) dark brown, with vegetation at surface (TOPSOIL)										
		SHALE, unweathered, gray	SPT 1	100	7-29-46 (75)	4.5		20.3	43	23	20	
2.5			SPT 2	100	50/5"	2.5		11.0				
5.0			SPT 3	100	35-50/3"	0		10.9				

Refusal at 6.8 feet.
Bottom of borehole at 6.8 feet.

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BORING NUMBER B7

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Split Spoon Refusal in Shale
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		LEAN CLAY, (CL) dark brown, with vegetation at surface (TOPSOIL)										
		SHALE, unweathered, gray	SPT 1	100	17-33-35 (68)	3.5		10.2				
2.5			SPT 2	100	15-26-50/4"	4.5		12.7				
5.0			SPT 3	100	50/3"	2.5		10.0				

Refusal at 6.3 feet.
Bottom of borehole at 6.3 feet.

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BORING NUMBER B8

CLIENT Lee's Summit R-7 School District
PROJECT NAME LEE'S SUMMIT WEST HS ROBOTICS BUILDINGS
PROJECT NUMBER 22-5547
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 07/07/22 **COMPLETED** 07/07/22
GROUND ELEVATION _____ **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY NG **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES Auger Refusal on Limestone
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	UNCONFINED COMP (PSF)
0.0		LEAN CLAY, (CL) dark brown, with vegetation at surface (TOPSOIL)										
		FAT CLAY, (CH) brown and orangeish brown, dry	SPT 1	86	3-3-50/2"							
2.5		LIMESTONE, highly weathered to moderately weathered	SPT 2	100	50/1"							

Refusal at 4.5 feet.
Bottom of borehole at 4.5 feet.