

KROGER STRUCTURED CABLING SYSTEMS (SCS)  
FOR TELECOMMUNICATIONS SYSTEMS AND  
RELATED WORK SPECIFICATION  
SECTION 271000

INSTALLATION SPECIFICATION



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## 1 PART 1 - GENERAL

### 1.1 SUMMARY

Structured Cabling System (SCS): This Section provides for a complete telecommunications structured cabling system that supports the Kroger network and other project systems as indicated or specified.

#### 1.1.1 Standards Compliance

The telecommunications structured cabling system (SCS) shall comply with all contract documents, specifications, drawings, manufacturer's instructions, and requirements of the Authority Having Jurisdiction (AHJ). In addition, the SCS shall comply with all Kroger requirements that have been communicated to the contractor in writing. Where conflicts exist between applicable documents or standards, the most stringent requirements shall apply. Provide a complete and operable system in compliance with the project drawings, specifications, referenced standards, all applicable building codes, and all requirements of the AHJ.

#### 1.1.2 General Compliance Requirements

Provide a complete and operable system in compliance with the project drawings, specifications, referenced standards, manufacturer's instructions, Owner requirements, all applicable building codes, and all requirements of the AHJ. Where conflicts exist between applicable documents or standards, the most stringent requirements shall apply. Drawings and specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Except where explicitly modified by a specific notation to the contrary, it shall be understood that the indication or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, provided complete. Work includes all items required for a complete system whether or not it is identified in the specifications or indicated on the drawings.

#### 1.1.3 Integration

The cable contractor is responsible for coordinating the overall system integration among trades, subcontractors, and suppliers unless specified or indicated otherwise. The work covered by this section of the specifications shall be coordinated with the related work indicated on the drawings or specified elsewhere under the project specifications. All work related to the SCS shall be performed under the direct supervision of the cable contractor.

#### 1.1.4 Authorized Product Manufacturers

Refer to Paragraph "Manufacturers" in this specification.

#### 1.1.5 Coordination of Work

Coordinate all work among the project specification sections and the contractor / subcontractors involved in this project. Coordinate installation work with all field conditions and the work of other trades. Minimum clearances and work required for compliance with NFPA 70, "National Electrical Code" and the manufacturer's instructions shall be provided. Comply with additional requirements specified or indicated for access and clearances. Verify all field conditions and dimensions that affect the selection and provision of materials and equipment, and shall locate equipment, devices, and wiring as required to comply with all contract requirements.

- **Field Conditions:** Verify all field conditions and dimensions that affect the selection and provision of materials and equipment, and shall provide any disassembly, reassembly, relocation, demolition, cutting, and patching required to provide the work specified or indicated, including relocation and reinstallation of existing wiring and equipment. Protect the existing facility, equipment, and wiring from damage resulting from the Contractor's operations. Extra charges for completion and contract time extension will not be allowed on account of field conditions or additional work required for complete and usable construction and systems.
- **Installation and Coordination:** Use judgment and care to install work to function properly and fit within building construction and finishes. Verify device/equipment-mounting heights as required by project conditions prior to rough-in. Route conduits and cabling associated with new equipment and systems above ceilings, in existing chases, and concealed within building structure, except where indicated or specified to be exposed.
- **Provide supplementary or miscellaneous items, appurtenances, devices, and materials necessary for a sound, secure and complete installation.** Comply with all project drawings and sections of the specifications for requirements that affect the work of this section. Completely coordinate the work of this section with the work of other Sections and provide a complete and fully functional installation.

#### 1.1.6 Complete and Usable Work

The scope of this contract includes all planning, design, materials, equipment, accessories, labor, supervision, project management, configuration, programming, testing, startup/commissioning services, and documentation costs **for a complete and operable system, meeting all requirements indicated on the drawings and contained in the specifications.** The drawings are diagrammatic, and the specifications are performance-based; provide complete and usable work in accordance with the contract documents, complying with all drawing, specification, and performance requirements. Provide all materials and equipment, along with all accessories and additional work required for field conditions, as well as additional work and accessories required for complete, usable, and fully functional construction and systems complying with all drawing, specification, and performance requirements, even if not specified or indicated. If necessary, in order to comply with all contract requirements, provide equipment with greater capabilities and capacities than those indicated.

- **Terminology:** As used in these specifications, "provide," means "furnish and install." "Furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support," and "install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project." Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete the work.
- **Examination:** Prior to submitting a proposal, the Contractor shall examine the site, review the contract drawings and specifications, and determine the exact extent of the work required.
- **Questions:** Should the bidder or contractor have any questions as to the intent of the drawings and/or specifications, quality of materials to be used, and work to be performed, questions shall be submitted in writing to the Owner and Owner's representative in the manner dictated by the Owner and/or Owner's representative. All answers and clarifications to the drawings and specifications will be issued in writing.
- **Claims:** Claims for extra payment will not be allowed due to unfamiliarity with the work to be performed by other trades, failure to coordinate the planning and construction of the work, or failure to comply with the drawings and specification requirements.

### 1.2 PERMITS

The contractor shall secure and pay for all licenses, permits, and inspection fees required by local agencies and/or other agencies having jurisdiction. Give notices, file plans, obtain permits and licenses, pay fees, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with specifications, drawings, addenda and change orders. The contractor shall provide all additional work required to comply with all local and other agencies having jurisdiction at no additional cost. The contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction where required by local codes and shall forward copies of same to the Owner and Owner's representative prior to request for project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations.

### 1.3 PROJECT CONDITIONS

#### 1.3.1 Field Verification

Carefully verify the location, ceiling heights, use and status of all material, equipment, and utilities that are specified, indicated, or deemed necessary for removal. Verify that all materials, equipment, and utilities to be removed are completely inactive and will not be required or in use after completion of the project. Replace with equivalent any material, equipment and utilities that were removed by the Contractor that are required to be left in place.

#### 1.3.2 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:

- Notify Owner in writing at least 14 days in advance of proposed utility interruptions.
- Do not proceed with utility interruptions without Owner's written permission.

#### 1.3.3 Protection of Completed Work

The Contractor shall be fully responsible for protecting the installed materials (including all cables) from start to finish of the project. This includes protection from physical damage, dust, chemical exposure, and paint overspray. If during any inspection cables are found to be compromised, the contractor shall retain the services of the cabling manufacturer to conduct a physical inspection of all materials, at the contractor's expense. All products determined out of compliance with

the manufacturer's specifications or installation practices shall be replaced by the contractor at no additional cost to the Owner.

#### 1.4 RELATED DOCUMENTS

General: Drawings and general conditions of the Contract, including General and Supplementary Conditions, project Scope of Work, project material list, and Owner's requirements shall apply to this section. All specification appendices shall be considered as contract requirements, including but not limited to tables, charts, diagrams, schedules, and referenced standards.

Coordinate the work in this section with the drawing requirements and the work specified in the other project specification sections.

#### 1.5 CODES AND STANDARDS

General: All work, including but not limited to cabling, pathways, support structures, wiring, equipment, installation, and workmanship shall comply with the latest editions of the requirements of the Authority Having Jurisdiction (AHJ), BICSI, National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the standards specified below. In case of discrepancy or disagreement between the documents noted above, the Contractor shall satisfy the most stringent requirements.

##### 1.5.1 Applicable Codes and Standards

Unless authorized by Kroger Distributed Networks or required by applicable project standards, project designs and specifications shall comply with the current version of the following industry standards:

- ANSI – American National Standards Institute
- ANSI/UL263, "Fire Tests of Building Construction and Materials".
- ANSI/UL723, "Surface Burning Characteristics of Building Materials".
- ANSI/UL1479, "Fire Tests of Through Penetration Firestop".
- ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard.
- ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
- ANSI/TIA-606, Administration Specification for Commercial Telecommunications Infrastructure
- ANSI/TIA-607, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- ANSI/TIA-758 Customer-Owned Outside Plant Telecommunications Cabling Specification
- ANSI/NECA/BICSI 568, Standard for Installing Commercial Building Telecommunications Cabling
- American Society for Testing Materials (ASTM).
- ASTM E 84, "Surface Burning Characteristics of Building Materials".
- ASTM E 119, "Fire Tests of Building Construction and Materials".
- ASTM E 814, "Fire Tests of Penetration Firestop Systems".
- BICSI – Telecommunications Distribution Methods Manual (TDMM)
- BICSI – Information Technology Systems Installation Methods Manual (ITSIMM)
- BICSI – Outside Plant Design Reference Manual (OSPDRM)
- IEEE 1100-2005 Recommended Practice for Powering and Grounding Electronic Equipment (Emerald Book)
- NEC - National Electrical Code, Life Safety Code
- NEMA - National Electrical Manufacturers Association
- NESC- National Electrical Safety Code
- NFPA 70 National Electrical Code
- NFPA 101 Life Safety Code
- OSHA - Occupational Safety and Health Administration
- TIA – Telecommunications Industry Association
- Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
- UL – Underwriters Laboratories, Inc.
- Local, county, state and federal regulations and codes in effect as of the date of installation.

##### 1.6 SUBMITTALS

Submittals shall be made in accordance with Owner general requirements specified in other sections, except as modified by additional requirements specified in this section. Submittals shall be submitted via email and include all information required

by the applicable specification sections. Submittals shall be presented in a clear and thorough manner and shall include all information required by the applicable specification sections. Verify quantity of submittal copies required with Owner and Owner's representative.

The Contractor shall not be eligible for extensions of contract schedule or additional charges resulting from additional reviews of submittals resulting from incompleteness, incorrect information, or non-compliance with the contract provisions.

Refer to paragraph "Substitutions" hereinafter for requirements pertaining to proposed product substitutions.

Refer to paragraph "Installer/Provider Qualifications" for requirements pertaining to contractor qualifications.

#### 1.6.1 Approval Submittals

Prior to ordering of materials, beginning work, and prior to the pre-installation meeting specified herein, submit the specified documentation required by the Owner, Owner's representative, or as specified in the project specification general requirements. Submittals of related systems shall be fully coordinated and submitted for review concurrently. Submit compliance certifications and submissions to the Authority Having Jurisdiction (AHJ) where specified and required.

- Detailed Bill of Materials to include item price, total quantity for each item and note any long lead items.
- The preliminary project schedule shall include all major work components that materially affect any work on the project.

#### 1.6.2 Shop Drawings

Submit shop drawings, as required, as a complete set within (30) days of award of contract. This includes fabrication drawings for custom-built equipment.

#### 1.6.3 Product Data

Submit product data (catalog cut sheets), as required, for system components, including installed features and devices.

#### 1.6.4 Samples

Product samples are not required unless requested in writing by Owner and/or Owner's representative.

#### 1.6.5 Submittal Review

The Owner will return submittals with review comments within 4 weeks of submission if the submittals are complete and in compliance with the project specifications. Claims for additional project schedule or costs resulting from submittal reviews shall be submitted in writing within two weeks of the submittal review comments, clearly indicating and documenting the reasons for the requested change in schedule or contract cost.

#### 1.6.6 Test Reports

Submit results of all required factory and field testing. Refer to Paragraph "Testing Procedures" in this specification for additional requirements.

#### 1.6.7 Record Drawings

During system installation, maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the Telecommunications SCS provided in this contract, to be used for record drawings. This set shall be kept up to date by neatly drawn hand annotations in red ink, reflecting all changes and additions made to the Telecommunications SCS. Copies of the final record drawings shall be provided in PDF, .DWG format, and/or hard copies as directed by the Owner and/or Owner's representative. Record drawings shall include:

- Telecommunications SCS and related systems
- Raceway and pathway systems, size, and location, for both exterior and interior; locations of all equipment and devices.
- Installed cable routes, equipment and outlet locations, and administration labeling information prior to project completion.

### 1.7 SUBSTITUTIONS

The Owner does not desire to make product substitutions unless absolutely necessary to accommodate product line revisions initiated by the manufacturer(s), and submission of product substitutions is not encouraged. The Owner reserves the right to reject proposed substitution requests and submissions of alternates without review or justification. Submission of product substitutions presented to maintain the overall project schedule will not be considered unless the contractor can clearly show that the specified products were correctly identified in the contractor's proposal with acceptable lead times from the

manufacturer and that procurement of products was immediately initiated after award of project contract, as evidenced by the date of submission of specified product submittals.

Where the Contractor proposes to use an item of material, equipment, or method of installation other than those indicated or specified in the Contract Documents, submit the proposed change in writing to the Owner and Owner's representative for approval. The proposed change request shall describe in detail the proposed changes and deviations and shall include a proposed contract schedule and contract cost change. The Contractor shall assume the cost of and the entire responsibility for any change to this work from the work as shown or specified, occasioned by approval of such item by the Owner and Owner's representative. In addition, the Contractor shall make all such arrangements and assume all costs occasioned by changes in the work of other trades that the Contractor may require in order to install the approved deviations or substitutions at no additional cost to the Owner. Where the proposed change requires additional review effort by the Owner or Owner's representative or Architect-Engineer, the Contractor shall reimburse the Owner, Owner's representative and Architect-Engineer at costs and billing rates mutually agreed to. Reimbursement for additional services is required prior to final approval of the proposed change. Non-payment of additional services will result in rejection of the proposed change and a reduction in the contract price to compensate the Owner, Owner's representative and Architect-Engineer for additional services resulting from the Contractor's proposed changes. The Owner reserves the right to reject any and all proposed changes, without review or justification.

Substitution requests during the project bidding phase will be considered only if submitted to the Owner and Owner's representative no less than 14 calendar days prior to the project bid date. Acceptance or rejection of the proposed substitution is at the Owners and Owner's representative sole discretion. No exceptions. Requests for substitutions shall be considered "NOT APPROVED" unless approval is issued in writing by the Owner and/or Owner's representative.

For equipment, cabling, wiring, materials, and all other products indicated or specified as "no substitutions" or "no alternates", the Owner does not expect nor desire requests for substitutions and alternate products other than those specified and reserves the right to reject proposed substitution requests and submissions of alternates without review or justification.

#### 1.7.1 Substitution Requests

Requests for consideration of manufacturers or products other than those specified or indicated must comply with the requirements specified below in order to be considered. Non-compliance with any of the specified procedures shall be justification for rejection of the request for substitution without review. Submission of incomplete or erroneous information shall be justification for rejection of the request for substitution without further review. Only one substitution request for a given product or product group will be considered, and substitution requests must be submitted by the approved contractor or bidding contractor; requests for substitutes from sales offices or manufacturers shall be rejected without review. If the initial substitution request is rejected for any reason, the contractor shall not be permitted to revise or amend the initial substitution request and shall immediately prepare submittals for the specified products and submit them for approval. Repeated submissions resulting from rejection of previous submissions will not be reviewed. Decisions of the Owner and Owner's representative shall be final.

- Acceptance or rejection of proposed substitution is at Owner and Owner's representative's sole discretion. No exceptions. Requests for substitutions shall be considered, not approved unless approval is issued in writing by the Owner and Owner's representative. Approval of substitutions during the bidding of the project will be issued in writing as a bid addendum to all identified bidders and will be available from the Owner's representative.
- The Owner and Owner's representative reserves the right to reject proposed substitution requests and submissions of alternates without review or justification. The Owner also reserves the right to purchase some or all specified project materials and furnish to the contractor for installation without justification.
- Substitution requests shall include complete submittal data as specified for project submittals pertaining to the materials and equipment addressed in the substitution request, which includes but is not limited to the following documentation. Comply with paragraph "Submittals" in this section and with submittal requirements as specified in the applicable specification section for the products under review.

#### 1.7.2 Construction Phase Remedies

If the Contractor installs or attempts to install substitute equipment, cabling, apparatus, wiring, materials, and any other products that were not approved in writing by the Owner and Owner's representative, or were specified as no substitutions or no alternates; the Owner and Owner's representative reserves the right to:

- Require the Contractor to remove the unapproved materials at Contractor's own expense and provide the approved materials.
- Disqualify the Contractor from further work, terminate the contract immediately, and replace Contractor with an alternate, invoicing Contractor for the labor and materials required to remove the unapproved equipment, cabling, apparatus, wiring, materials, or any other unapproved products.

### 1.7.3 Post-Completion Remedies

If the work has already been completed when the unauthorized material is discovered, the Owner reserves the right to withhold all remaining payments to the Contractor and use an alternate Contractor to remove the unapproved materials and replace them with approved materials. The Owner will invoice the original Contractor for any remaining costs, after the payments have been applied to the contract balance due.

## 1.8 CONTRACTORS SYSTEM WARRANTY DOCUMENTATION

The Contractor shall warrant all labor to be free of workmanship defects for a period of 12 months from the date the work is completed. During this 12-month period, the Contractor will promptly repair, at no cost to the customer, any defects that are a direct result of labor workmanship. All materials shall be warranted according to the manufacturer's provided warranty.

Note: All uncertified work performed by the Contractor shall be corrected and brought into certification by the Contractor. This includes, but is not limited to, the responsible Contractor paying a third party to perform final termination and testing of the complete system at the Contractor's expense, with no additional cost to Kroger or Kroger subsidiaries. If the system warranty is rejected, the Contractor is not relieved of this obligation and must bring the system into specification. The final system shall carry manufacturers' warranties. Failure to do so may forfeit final payment for work performed on this system and may include Kroger billing the Contractor for costs associated in bringing the system into compliance.

## 1.9 MANUFACTURER'S SYSTEM WARRANTY

Panduit Certification Plus<sup>SM</sup> System Warranty is a 15, 20 or 25-year standard-based, performance warranty covering Panduit-branded copper and fiber connectivity hardware, and Panduit-branded cable or approved manufacturer's cable, used in structured cabling systems that meet the project requirements.

Corning Network of Preferred Installers (NPI) offers end users up to a 25-year warranty for installations when all products in the fiber cabling solution are Corning-covered products, including fiber optic cables, hardware, connectivity, and pre-terminated systems.

The Leviton Network Solutions Warranty provides a Standard Limited Product Warranty of 1-year and a Limited Lifetime Warranty for Certified Projects on all Leviton Category Rated Commercial Grade Cabling System Products.

All Kroger installations must be certified and warranted under the manufacturer's program being installed, therefore, the Contractor must meet the requirement of the manufacturer's warranty programs. No substitutions will be permitted.

The Contractor shall provide copies of their manufacturer's warranty certificates with their bid response. Contractors who do not hold or cannot provide the current manufacturer's warranties as stated herein shall not engage in installation work within a Kroger facility, unless expressly authorized in writing by Kroger Distributed Networks. Individual certificates of personnel do not satisfy this requirement.

The Contractor must apply for system warranties from the manufacturer. Copies of each application shall be submitted to Kroger and the project SCS designer no later than 10 working days after completion of project. Failing to apply for system warranties may delay or forfeit final payment for work performed. The installed system is not considered complete until the system warranty has been successfully accepted and issued by the manufacturer.

## 2 PART 2 - PRODUCTS

### 2.1 GENERAL

All cables, connectors, hardware, and equipment that comprise the Communications Cable Plant shall be installed according to ANSI/TIA/EIA-568-x Commercial Building Telecommunications Cabling Standard, and other BICSI and manufacturer installation guidelines as specified or required.

### 2.2 MANUFACTURERS

The specified manufacturers for the structured cabling system (SCS) products and equipment are listed in the project material list. Refer to the project material list, project Scope of Work, and project drawings for additional requirements and acceptable manufacturers for related work. No substitutions permitted without written approval from the Owner and/or Owner's representative.

Request for substitutions or approval of alternate products, material, or equivalent shall be made in accordance with paragraph "Substitutions" of this section.

Substitutions and Alternates: Use of equivalent products by other manufacturers shall be permitted only when approved in writing by the Owner and Owner's representative.

### 2.3 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

Materials and equipment shall bear the manufacturer's name or trademark and mode/derail number permanently marked. No substitutions will be permitted for specific products.

All materials and equipment shall be new, free from defects, installed in accordance with the manufacturer's current published recommendations, in a neat manner and in accordance with standard industry practices.

Where no specific material, apparatus, or appliance is mentioned, any standard, first-class product made by reputable manufacturer regularly engaged in the production of such material may be used providing it conforms to the contract requirements and meets the approval of the Owner.

### 2.4 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

### 2.5 SUITABILITY

Provide products that are suitable for intended use, including but not limited to, environmental, regulatory, and electrical. NOTE: Freezer and wet room applications will require special communications products. Provide in accordance with Kroger specifications.

### 2.6 COMPATIBILITY OF RELATED EQUIPMENT

Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

Provide products that are suitable for intended use, including, but not limited to, environmental, regulatory, and electrical.

### 2.7 STRUCTURED CABLING SYSTEM (SCS); GENERAL PRODUCT REQUIREMENTS

The telecommunications SCS shall comply with the specifications in this section and shall be comprised of data backbone fiber optic cables, voice backbone copper cables, patch panels, connecting hardware, horizontal copper cables, and jack modules at the equipment outlets for voice, data, and telecommunications SCS services. Locations of equipment shall be as indicated on the drawings, unless directed otherwise by the Owner and/or Owner's representative.

#### 2.7.1 Products Listings

Systems and equipment shall be listed and labeled by a nationally recognized testing laboratory (NRTL) for compliance with the referenced standards. All items of the SCS shall be listed as a product of a telecommunications system manufacturer under the appropriate category by the NRTL and shall bear the appropriate label.

Materials and equipment shall be the cataloged products of manufacturers regularly engaged in production and installation of telecommunications structured cabling systems and shall be manufacturer's latest standard design that complies with the specification requirements.

#### 2.7.2 Performance

The performance of all materials and equipment proposed by the contractor for use on the project shall comply with or exceed the manufacturer's published performance specifications in effect at the time of the product data submittal by the



Contractor. The Contractor shall notify the Owner and Owner's representative in writing if any telecommunications SCS products furnished by the manufacturer or installed by the Contractor do not meet the manufacturer's published performance specifications.

## 2.8 WORK AREA OUTLETS

Equipment Outlets for Copper Cabling: Provide equipment outlets (EO's) for all services in the configurations specified and at the location indicated in the project drawings. EO's shall include outlet boxes, extension rings (where required/specified/indicated), faceplates and modular jacks for each cable. EO's shall be labeled per Kroger's labeling standard. Outlet boxes and extension rings shall comply with additional requirements indicated on the project material list and/or project drawings; sizes shall be adequate for the quantities and configurations of jacks required. Outlet cover plate and jack module colors shall be as indicated and/or specified on the project material and/or project drawings. General requirements for EO components are as follows:

### 2.8.1 Modular Jacks for Copper Cables

General: 8-position, 8-conductor, UL listed, UTP jack module shall terminate solid 4-pair, RJ-45 type rated for conductors 24 – 22 AWG and equipped with a universal label coded for T568A and T568B wiring schemes. Comply with requirements on drawings and additional detailed performance specifications requirements below:

Performance: Meet or exceed the manufacturer's published performance specifications for the products specified, per ANSI/TIA/EIA-568 latest revision

### 2.8.2 Faceplates

Standard product of the SCS manufacturer, with provisions for securing the outlet box/wall surface and labeling as specified below in this section. Construction shall be stainless steel or high-impact flame-retardant UL-rated 94V-0 rated plastic, as specified, or indicated. Provide blank filler plates to match faceplate color for unused jack positions and arrange jacks within faceplates per faceplate layout configurations drawing. Modular jack capacities shall be as follows for the mounting configurations specified:

- Recessed construction for mounting on wall boxes or wall surfaces. Accepts one to six jack modules, inclusive; quantity of active jack modules as indicated.
- Modular furniture: Accepts one to four jack modules, inclusive; quantity of active jack modules as indicated.

### 2.8.3 Work Area Outlet Equipment Connection Cords

Comply with requirements for copper patch cords specified in this section. Provide patch cord quantities and lengths indicated by complying with the project material list, project Scope of Work, and project drawings.

## 2.9 CROSS-CONNECT SYSTEM – COPPER CABLING

Cross-Connect Equipment: Cross-connect equipment shall provide a passive transition between backbone cabling, horizontal cabling, and network equipment. Provide patch panels as specified or indicated by complying with the project material list, project Scope of Work, and project drawings.

### 2.9.1 Patch Panels

Patch panels shall facilitate proper termination of cabling, and allow neat and orderly cross-connect administration, labeling, and move/add/change (MAC) management. Provide the horizontal and vertical wire management systems as indicated or specified in this section by complying with the project material list, project Scope of Work, and project drawings.

- Construction: Patch panels shall be suitable for mounting within the racks/cabinets/enclosures.
- Performance: Meet or exceed the manufacturer's published performance specifications for the products specified.
- Modular Jack Modules: Comply with specifications in this section for modular jacks specified in paragraph "Modular Jacks for Copper Cables".
- Identification: The front of each port shall have manufacturer's printed port assignments.
- Quantities: Provide a quantity of 24 and 48-port patch panels in each telecommunications space to support the number of equipment outlets to be installed with 25% spare capacity considered.
- Accessories: Provide wire management and all other accessories required for a complete installation by complying with the project material list, project Scope of Work, and project drawings.

### 2.9.2 Patch Cords

To maintain channel integrity, copper patch cords shall be fabricated to meet the same performance parameters, as the cable used for horizontal drops. Provide patch cord quantities and lengths indicated on the project material list, project Scope of Work, and project drawings.



Note: Under no circumstances should a telecommunications patch cable be field manufactured for use on any device connected to Kroger's network, unless specifically noted in the project drawings or approved by Kroger Distributed Networks.

## 2.10 CROSS-CONNECT SYSTEM – FIBER OPTIC CABLING

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

### 2.10.1 Fiber Optic Patch Cords

To maintain channel integrity, fiber optic patch cords shall be fabricated to meet the same performance parameters as the corresponding fiber optic cable. Provide fiber optic patch cord configurations, quantities and lengths as indicated on the project material list, project Scope of Work, and project drawings.

## 2.11 CABLING – HORIZONTAL COPPER

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

- Construction: 4-pair bonded or non-bonded unshielded twisted pair (UTP), based on the project material list, project Scope of Work, and project drawings, NRTL-listed for the fire ratings specified below, and complying with ANSI/TIA/EIA 568 latest revision. Conductors shall be insulated with an overall lead-free cable jacket.
- Fire Ratings: Cable fire ratings in their environment where installed shall comply with all applicable articles of the National Electrical Code (NEC) and all other applicable building codes. Verify all cable ratings with the Owner and Owner's representative prior to project commencement.
- Performance: Meet or exceed the manufacturer's published performance specifications for the products specified.
- Identification: Comply with identification requirements specified in this section. The outer jacket of each cable shall be factory labeled to denote the manufacturer's name, catalog number, UL classification, cable size, and ANSI/TIA/EIA Category. Cable jacket colors shall be verified by the Contractor with the Owner's representative for the various services. The Owner reserves the right to revise cable color selections by selecting from the manufacturer's standard colors. Color identification of all UTP conductor pairs shall comply with ANSI/TIA/EIA 568 latest revision as follows:
  - White/Blue
  - White/Orange
  - White/Green
  - White/Brown

## 2.12 CABLING – BACKBONE COPPER (RISER BACKBONE)

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

- Construction: 4-pair bonded, non-bonded or multi-pair unshielded twisted pair (UTP), NRTL-listed for the fire ratings specified below, and complying with ANSI/TIA 568 latest revision.
- Fire Ratings: Cable fire ratings in their environment where installed shall comply with all applicable articles of the National Electrical Code (NEC) and all other applicable building codes. Verify all cable ratings with the Owner's representative prior to project commencement.
- Performance: Meet or exceed the manufacturer's published performance specifications for the products specified.
- Identification: Comply with identification requirements specified in this section. The outer jacket of each cable shall be factory labeled to denote the manufacturer's name, catalog number, UL classification, cable size, and ANSI/TIA Category. Cable jacket colors shall be verified by the Contractor with the Owner's representative for the various services. The Owner reserves the right to revise cable color selections by selecting from the manufacturer's standard colors. Color identification of all UTP conductor pairs shall comply with ANSI/TIA/EIA 568 latest revision.
- Sizing and Conductor Quantities: As specified or indicated on the project material list, project Scope of Work, and project drawings.

## 2.13 CABLING – BACKBONE FIBER OPTIC

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

## 2.14 EQUIPMENT RACKS, WALL-MOUNT ENCLOSURES, CABINETS AND WIRE MANAGEMENT

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

### 2.14.1 Equipment Racks

Equipment racks shall be 7-ft. high floor mounted standard racks with a minimum load rating of 600 pounds. Racks shall be black powder coat finish and shall comply with EIA310-D. Racks shall be UL listed, self-supporting, with horizontal and vertical wire management systems to facilitate the proper termination of cabling, and allow neat and orderly cross-connect administration, labeling, and move/add/change (MAC) management. Horizontal cable channels shall intersect seamlessly with vertical cable channels. Provide covers for all cable management channels.

### 2.14.2 Wall Mount Enclosures

Wall mount enclosures shall have 19" EIA310-D compliant mounting rails, two pair of #12-24 rails, fully adjustable, center swing-out section provides front/rear access to cables, reversible cabinet for left- or right-hand swing out, minimum usable depth of 30-inches (unless noted otherwise on the project material list, project Scope of Work, and project drawings), and vented side panels for air-flow with fan assembly and dust kit. Weight capacity dependent on type and size of wall mount enclosure. Refer to the project material list, project Scope of Work, and project drawings for mounting method requirements.

### 2.14.3 Equipment Cabinets

Comply with EIA310-D. Cabinets shall be UL listed, self-supporting, with horizontal and vertical wire management systems to facilitate the proper termination of cabling, and allow neat and orderly cross-connect administration, labeling, and move/add/change (MAC) management. Horizontal cable channels shall intersect seamlessly with vertical cable channels. Provide covers for all cable management channels.

## 2.15 ENCLOSURES

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

Comply with NEMA 250, UL 50, UL 508, and NEC. Provide features and accessories specified or indicated.

- Construction Requirements: Minimum requirements are specified below; provide greater protection where specified or indicated, or where required to meet the environmental conditions of the installed location.
- Indoor Dry Locations: NEMA 1 construction, baked enamel gray ANSI 49 or ANSI 61 finish on cleaned, phosphatized, primed steel. Provide other finishes and colors where specified or indicated. NOTE: Manufacturing division will only allow NEMA 1 type enclosures in office areas. Under no circumstances shall NEMA 1 type enclosures be used in any production area or area subject to dust.
- Outdoor or Wet Locations:
  - NEMA 3R construction, baked enamel gray ANSI 49 or ANSI 61 finish on galvanized steel. Provide other finishes and colors where specified or indicated on project drawings, project specifications and project material lists.
  - Provide NEMA 4, NEMA 4X and Type 12 ratings, special enclosures, and special materials or finishes where indicated or specified on the project material list, project Scope of Work, and project drawings.

## 2.16 SURGE PROTECTIVE DEVICE (SPD)

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

- General: Where indicated, provide copper circuits with the SPD protection specified below. Connect the SPD ground terminal with an AWG copper bonding conductor sized according to manufacturer's specifications between the SPD ground lug and the nearest telecommunications ground bus or as indicated on the project drawings.
- Performance: Meet or exceed the manufacturer's published performance specifications for the products specified.

## 2.17 RACEWAYS

- Rigid steel conduit: Comply with UL-6. Hot dipped galvanized for both exterior and interior of conduit.
- Rigid aluminum conduit: Comply with UL-6.
- Rigid intermediate steel conduit: Comply with UL 1242. Hot dipped galvanized exterior, enamel-coated interior.
- Electric metallic tubing: Comply with UL 797. Hot dipped galvanized exterior, enamel-coated interior.

- Flexible metal conduit: Comply with UL-1 and UL-360 as applicable. Heavy galvanized corrugated steel core, with thermoplastic cover. Liquid tight flexible metal conduit shall be used for connection to vibrating equipment. Flexible conduit shall not be used in lieu of conduit bends and offsets.
- PVC conduit: Comply with UL 651, listed for use with 90°C conductors operating at 90° C.
- Conduit fittings: Fittings shall be watertight and of the same material as conduit. Fittings shall be single piece threaded type hot dipped galvanized for RGS conduit and IMC conduit.
- Electric metallic tubing fittings: Fittings shall be watertight hexagonal compression type with insulated throat. Setscrew connectors shall not be used. Crimp-type connectors shall not be used.
- Flexible metal conduit fittings: Insulated throat type
- Conduit expansion fittings: O-Z Gedney type AX or TX as appropriate or approved equivalent by Crouse-Hinds or Appleton.

## 2.18 OUTLET BOXES

### 2.18.1 Interior/Dry Location Device Boxes

- Acceptable Manufacturers: Steel City, RACO, or Appleton. Equivalent products by other manufacturers may be used.
- Construction: Steel with knockouts and plaster extension rings where necessary to set flush with the finished surface, unless otherwise noted or specified. Boxes shall be 2-1/8 inches deep, double-gang with a single-gang mud ring.

### 2.18.2 Exterior/Wet Location Device Boxes

- Acceptable Manufacturers: Crouse-Hinds FS or FD, O-Z Gedney or Appleton. Equivalent products by other manufacturers may be used.
- Construction: Cast iron, zinc-plated with weatherproof gasket covers.

## 2.19 PULL BOXES, JUNCTION BOXES AND WIREWAY

- Acceptable manufacturers for pull boxes, junction boxes and wireway: Square D, B-Line, Hoffman, Rittal or Hammond. Equivalent products by other manufacturers may be used.
- Construction: Boxes and wireway shall have removable screw-fastened covers, and shall be made of galvanized steel, of metal gauge and physical size as required by the NEC for the number and size of conduits and conductors installed, unless a larger size is specified or indicated

## 2.20 ELECTRICAL SUPPORTING DEVICES

- Acceptable manufacturers for electrical supporting devices are as follows: U-Channel Strut, Caddy, B-Line, GS Metals, Kindorf or equivalent product. NOTE: In Manufacturing division facilities, U-Channel Strut, Unistrut or other hangers of similar design **shall not** be used.

### 2.20.1 U-Channel Strut

- Acceptable manufacturers for U-Channel Strut: Unistrut, B-Line, GS Metals, Kindorf or equivalent products.
- U-Channel Strut Systems: Carbon steel, 12-gage minimum 1-5/8-inch square steel channels, with 9/16-inch diameter holes or slots in top surface, at a 1-7/8 inch spacing. Provide fittings and accessories that mate and match with U-channel strut and are of the same manufacturer. Strut systems in exterior or wet locations shall be AISI Type 316 stainless steel or hot-dipped galvanized steel complying with ASTM A570 Grade 33 and ASTM A123 and shall have Type 316 stainless steel hardware. Provide galvanizing, special finishes, and hardware where specified or indicated. Provide fiberglass, coated, aluminum, or stainless-steel strut channel and related hardware where specified or indicated.
- NOTE: U-Channel Strut **shall not** be used in any Manufacturing facility.

### 2.20.2 Anchors

- Acceptable manufacturers for anchors: Hilti, Unistrut, B-Line, GS Metals, Kindorf or equivalent products.
- Materials: Hangers and clamps shall be made of durable materials suitable for the application involved. Hanger assemblies shall be protected by galvanizing, or other suitable preservative methods to prevent corrosion.
- Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- Fasteners: Types, materials, and construction features shall be as follows:
- Expansion Anchors: Carbon steel wedge or sleeve type.
- Toggle Bolts: All steel springhead type.

## 2.21 J-HOOK SUPPORT SYSTEM

### 2.21.1 Manufacturers

- Acceptable Manufacturers: VENT Caddy Erico, Cablecat Series or Cooper B-Line, BCH Series.

### 2.21.2 General Requirements

- Be listed by the NRTL for installation into a plenum space, where necessary.
- Be specifically designed for telecommunications cables.
- Bear a surface of enough width to comply with required bend radii of high-performance cables.
- Have flared edges to prevent damage while installing cables.
- Include a top latch to keep cable within the hook. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

## 2.22 CABLE TRAY SYSTEMS

Comply with the telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

### 2.22.1 Acceptable Manufacturers

Each cable tray type shall be a complete system product of a single manufacturer, unless specified or indicated otherwise. Acceptable cable tray manufacturers are:

- Wire Basket: Cablofil by Legrand
- Cable Runway: Chatsworth Products, Inc.
- Ladder: B-Line, GS Metals

### 2.22.2 General Requirements:

- Cable Tray Schedule: Refer to the project material list, project Scope of Work, and project drawings for cable tray types, sizes, configurations, materials, finishes, ratings, accessories, and additional requirements. Cable tray installations shall be comprised entirely of standard components regularly manufactured by the cable tray manufacturer. Custom accessories and field modification of accessories or components shall not be permitted, except where specifically indicated or specified otherwise, and as authorized in writing by the cable tray manufacturer, the Owner and/or the Owner's representative.
- Standards: Comply with NEMA VE 1, "Metal Cable Tray Systems," for materials, sizes, and configurations. Except as otherwise indicated, provide cable trays of materials, types, classes, and sizes indicated, with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features. Cable trays shall be NRTL listed and labeled.
- Accessories and Hardware: Provide accessories where specified, indicated, or required for the installation to protect, support, and install a cable tray system. Accessories and hardware shall be of the same materials and finishes as cable tray and shall include but are not limited to; section splice plates, expansion plates, blind-end plates, expansion splices; ladder dropouts, and barriers. Provide all accessories required to comply with the manufacturer's requirements and to provide a complete and operable system.
- NOTE: Manufacturing division does not permit continuous threaded rod (off-thread) for support hangers. Rods must be solid and only have thread on ends necessary to secure hanger.

### 2.22.3 Cable Tray Types

Unless specified or indicated otherwise, cable tray in telecommunications spaces (EF, ER, TR and TE) shall be the runway type; cable tray outside of telecommunications spaces shall be the wire basket type. A ladder type tray shall be provided only where specifically indicated or specified in the project drawings, project specifications and project material lists.

#### 2.22.3.1 Wire Basket

Provide cable tray system complete with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features specified below:

- Zinc Dichromate: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc dichromate in accordance with ASTM B633 SC2.
- Stainless Steel: Straight sections and accessories shall be made from AISI Type 304 Stainless Steel.

- Painting: Where specified or indicated, provide a factory-applied paint finish over cleaned zinc dichromate surfaces; color shall be manufacturer's standard or custom as specified or indicated.
- Pre-Galvanized Accessories: Where specified or indicated, wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.
- Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

#### 2.22.3.2 Runway (Telco Style)

Provide cable tray system complete with connector assemblies, supporting apparatuses and grounding as indicated on the drawings.

- Construction: Runway shall be tubular construction, ladder type with 1-1/2-inch height stringers and welded rungs.
- Load Ratings: Cable runway shall be capable of carrying a uniformly distributed load of 130 pounds per foot on a 10 feet support span with a safety factor of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capacities.
- Standards: Installation and configuration shall conform to requirements of ANSI/EIA/TIA Standards 568 and 569, NEC, and applicable local codes.

#### 2.22.3.3 Ladder

Comply with additional requirements for size, rung spacing, loading depth, width, finish, NEMA class, material, and grounding as indicated on the drawings. Provide connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features specified below:

Materials and Finish: Provide materials/finish types as indicated or specified:

- Aluminum: Center rails and rungs shall be extruded from Aluminum Association Alloy 6063. Fabricated parts shall be made from Aluminum Association Alloy 5052.
- Pre-Galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
- Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates shall be hot dip galvanized after fabrication; mill galvanized covers are not acceptable.
- Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

Types and Configurations: Ladder tray types include rung bottom, solid bottom, and ventilated trough type cable trays.

- Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Spacing in radius fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radius edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung shall be capable of supporting a 200-pound concentrated load with a safety factor of 1.5 when tested in accordance with NEMA VE-1.
- Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4-inch rectangular holes punched along the width of the bottom.
- Solid bottom trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inch and shall be spaced 6 inches on center.

Rungs: Single continuous square tube with radius corners. Rungs shall be mechanically connected to the center rail in at least two places, symmetrical about the center rail, with ends finished to protect installers and cables.

Splices and Connectors: Splice plates shall be provided with all straight sections and fittings and shall be the bolted type constructed as specified below for each tray type. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.

- Aluminum Tray: Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. Provide Type 316 stainless steel hardware for outdoor aluminum cable tray.
- Steel Tray (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or chromium zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

## 2.23 FIRE STOP SYSTEMS

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

Fire-stop penetrations shall be provided where required, with all work necessary to maintain the fire ratings of the walls and floors to be penetrated. Provide UL listed firestopping systems selected for the specific installation as required to comply with all applicable codes and requirements of the Authority Having Jurisdiction (AHJ) in maintaining the fire ratings of walls and floors. Comply with additional specification requirements indicated on the project material list, project Scope of Work, and project drawings.

### 2.23.1 Penetrations

Firestop systems shall be comprised of the item or items penetrating the fire rated structure; the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems shall comprise an effective block for fire, heat, vapor, and pressurized water stream. All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). All penetrating items, including but not limited to riser slots and sleeves, cables, conduit, cable tray, and raceways shall be properly fire stopped. Comply with manufacturer's instructions, building codes, National Electrical Code, and additional specification requirements indicated on the project material list, project Scope of Work, and project drawings.

### 2.23.2 Products

Fire rated pathway devices shall be provided in all locations to support frequent cable moves and changes, unless specified or indicated otherwise. Provide products that are either mechanical in design, or products that upon curing, do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during or after construction.

### 2.23.3 General

Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

#### 2.23.3.1 Firestop Sealants

Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.

#### 2.23.3.2 Firestop Putty

Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.

#### 2.23.3.3 Fire Rated Cable Pathways

STI "EZ-PATH" device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill.

#### 2.23.3.4 Cable Trays

Where cables in trays pass through fire-rated penetrations walls, floors, or ceilings, stop the tray at least 6 inches from the barrier. If a specific firestopping system is not indicated, provide STI "EZ-PATH" fire rated cable pathways in sufficient sizes and quantities to provide a total usable pathway cross sectional area of at least 60% of the cable tray cross-sectional area at the location of the penetration. Provide appropriate firestopping around their exterior at the penetration.

#### 2.23.3.5 Conduit Sleeves

Conduit sleeves shall have removable intumescent firestopping putty applied to the sleeve interior. Unused conduit sleeves shall have threaded caps in addition to the firestopping putty.

### 2.24 GROUNDING AND BONDING SYSTEMS

Comply with telecommunications equipment requirements in the project material list, project Scope of Work, and project drawings.

#### 2.24.1 General Requirements

The facility shall be equipped with a complete grounding and bonding system (GBS) that includes a telecommunications bonding backbone (TBB) and telecommunications ground buses. Comply with UL467; all conductors and equipment shall be listed and labeled by NRTL. Provide types of materials indicated and specified on the project material list, project Scope of Work, and project drawings. project drawings, project specifications and project material lists.

#### 2.24.2 Telecommunications Ground Conductors

Unless specified or indicated otherwise, ground conductors shall be single conductor soft-drawn copper with 600V THHN/THWN green insulation, rated for dry and wet locations. Conductor sizes shall be standard American Wire Gauge (AWG) sizes. Conductors #8 AWG and larger shall be stranded, #10 AWG and smaller shall be solid, unless specified or indicated otherwise on the project material list, project Scope of Work, and project drawings.

#### 2.24.3 Telecommunications Ground Conductors in Exterior Locations

Comply with requirements specified above, except that ground conductors below grade outside of a raceway shall be uninsulated.

#### 2.24.4 Ground Rods

Copper clad steel, 3/4 inch by 10 feet minimum, 0.010-inch minimum copper outer sheath.

#### 2.24.5 Telecommunications Ground Buses

Provide complete factory-fabricated and assembled units in compliance with requirements indicated. Field fabrication of ground bus assemblies is not permitted. Where grounding drawings indicate conductor connections with AWG sizes other than specified above, provide additional compression lugs by installer of appropriate size for the conductors to be terminated.

#### 2.24.6 Telecommunications Ground Conductor Splices and Connections

##### 2.24.6.1 General

Splices shall not be permitted except when indicated or specified on the project material list, project Scope of Work, and project drawings. Splices at other locations are allowed only with written authorization of the Owner's representative.

##### 2.24.6.2 Exothermic Connections

Exothermic process shall weld copper and steel to produce a permanent electrical connection that will not loosen or increase in resistance. The finished connection shall provide an ampacity that exceeds that of the conductors being joined. Utilize the manufacturer's graphite molds.

##### 2.24.6.3 Compression Lugs

Two-hole electroplated tinned copper, sized for the associated conductor.

##### 2.24.6.4 Mechanical Lugs and Clamps

Mechanical compression type, size as appropriate for the associated conductor and bonded equipment.



### 3 PART 3 - EXECUTION

#### 3.1 COMPLETENESS

The SCS cabling/wiring systems shall be complete and functional, with all labor, services, equipment, testing, and materials required.

#### 3.2 GENERAL INSTALLATION REQUIREMENTS

Telecommunications Spaces (EF, ER, TR and TE): The telecommunications spaces shall house all equipment, cabling, and devices indicated or specified in the project drawings, project specifications and project material lists. Racks shall be placed in a manner that shall allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If one mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6" to the wall or as noted in the project drawings to allow room for vertical management. Where there is more than one rack, the racks shall be ganged with vertical management hardware to provide interbay cable management. Ganged rack frames shall be placed in a manner that shall allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly. Coordinate installation and locations of all cabling, devices and equipment with the Owner, Owner's representative and other installers/subcontractors involved in this project. Refer to paragraph "Pre-installation Meeting" in this section for requirements for project installation planning meetings. Equipment shall be grounded in accordance with project drawings and project specifications, EIA/TIA-607, and NEC. Comply with separation requirements between telecommunications and other types of wiring as required project drawings and specification, and NEC Article 800-52, Installation of Communication Wires, Cables, and Equipment

#### 3.3 TELECOMMUNICATIONS SCS WORK GENERAL REQUIREMENTS

##### 3.3.1 General

Sequence, coordinate, and integrate the various elements of Telecommunications SCS, materials, and equipment. Comply with the following requirements as a minimum:

1. Participation during all cut-over phases of the project.
2. Preparation of progress reports as required by the Owner's project team.
3. Preparation of post-construction submittals including as-built drawings, field test reports, warranty, and close-out documentation.
4. Protection of the Owner's Facility: effectively protect the Owner's facility, equipment and materials from dust, dirt, and damage during construction; remove protection at completion of project.
5. Complete installation, testing, and commissioning of all Communications Cable Plant.
6. Coordinate systems, equipment, and materials installation with other building components.
7. Verify all dimensions by field measurements.
8. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.
9. Coordinate the installation required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
10. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
11. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom and access for service and maintenance as possible.
12. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, request direction in writing from the Owner and/or the Owner's representative.
13. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.
14. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
15. Provide access panel or doors where units are concealed behind finished surfaces.
16. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
17. Comply with all requirements and work indicated in the project material list, project Scope of Work, and project drawings.



18. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of the Owner and in accordance with code requirements.
19. Install equipment and cabling/wiring to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel or roof curbs as appropriate.
20. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall and ceiling mounting of equipment as required.
21. Provide steel supports and hardware for proper installation of hangers, anchors, guides, and other support hardware.
22. Obtain and analyze catalog data, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
23. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Practice of American Institute of Steel Construction.
24. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void the warranty.

### 3.4 EQUIPMENT INSTALLATION

#### 3.4.1 General

Install equipment in locations as indicated, according to manufacturer's written instructions. Install equipment level and plumb. Install wiring and cabling between equipment and all related devices.

#### 3.4.2 Mounting

For equipment at walls, bolt units to wall or mount on structural steel channel strut bolted to the wall. For equipment not on walls, provide freestanding racks fabricated or structural steel members and slotted structural steel channel strut. Use feet consisting of 0.25-inch-thick steel plates, 6-inch square, bolted to the floor. Use feet for welded attachment of vertical posts not over 3 feet on center. Connect the posts with horizontal u channel steel strut and bolt the equipment to the channels.

#### 3.4.3 Cleaning

Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish. Clean devices internally using methods and materials as recommended by the manufacturer.

#### 3.4.4 Connections

Tighten wiring connectors, terminals, bus joints, and mountings, including lugs, screws, and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where the manufacturer does not publish connection or terminal torque values, comply with the torque values specified in UL 468A and UL 468B.

### 3.5 DELIVERY, STORAGE, AND HANDLING

#### 3.5.1 Delivery

Delivered materials and equipment shall be in manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life if applicable; qualified testing/inspection agency's classification marking. Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

#### 3.5.2 Storage and Protection

Store and protect products in accordance with manufacturer's instructions. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

### 3.6 CUTTING AND PATCHING

#### 3.6.1 General

Provide all cutting, patching, and core drilling as necessary for the telecommunications work. Locate holes and outlets to be drilled and coordinate with work of other trades.

Patch adjacent work disrupted by installation of new work including insulation, walls, and wall covering, ceiling and floor covering and other finished surfaces. Patch and/or paint openings and damaged areas equal to existing surfaces.

Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt.

In addition, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Install equipment and materials in existing structures.

#### 3.6.2 Demolition and Removal

Cut, remove, and legally dispose of selected equipment, components, and materials as indicated, including but not limited to removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by the new Work.

Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

#### 3.6.3 Protection of Work

Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. During cutting and patching operations, protect adjacent installations. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

### 3.7 PENETRATIONS AND SLEEVES

#### 3.7.1 General

Coordinate work with other Sections. Set sleeves in forms before concrete is poured. Provide core drilling as necessary if walls are poured, or otherwise constructed, without sleeves and wall penetration is required. Do not penetrate structural members. Provide sleeves and packing materials at all penetrations of foundations, walls, slabs (except on-grade), partitions, and floors. Sleeves shall meet the requirements of the pertinent specifications. Lay out penetration and sleeve openings in advance, to permit provision in work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed.

#### 3.7.2 Sleeve Fill

Sleeves that penetrate outside walls, basement slabs, footings, and beams shall be waterproof. Fill slots, sleeves and other openings in the floors or walls if not used. Fill spaces in openings after installation of conduit or cable. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. The fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke, and fumes. Sleeves through floors shall be watertight and shall extend a minimum of 6 inches above floor surface. Where raceways passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.

#### 3.7.3 Conduit Sleeves

1. Annular space between conduit and sleeve shall be at least ¼ inch.
2. Sleeves shall not be provided for slabs-on-grade unless specified or indicated otherwise.
3. For sleeves through rated fire walls and smoke partitions, comply with requirements for firestopping specified in section "Fire Stop Systems".

#### 3.7.4 Telecommunications Spaces

For telecommunications spaces, provide required amount of conduit sleeves and associated mounting hardware through the drop ceiling or extended into the ceiling space to transition all cabling to the cable runway as indicated on the project drawings.

For remote telecommunications enclosures, provide the required conduits and mounting hardware extended into the ceiling space as indicated on the project drawings.

#### 3.7.5 Cable Trays

All new cable tray pathways shall not penetrate fire-rated walls. Cable tray shall stop within 6-inches of the wall and fire-rated wall shall include STI EZPath product or equivalent approved in writing by the Owner and Owner's representative.

#### 3.7.6 Supports

Do not support piping risers or conduit sleeves.

#### 3.7.7 Future Use

Identify unused sleeves and slots for future installation.

### 3.7.8 Core Drilling

Core drilling shall be avoided where possible. Where core drilling is unavoidable locate all required openings prior to coring. Coordinate openings with other trades and utilities and prevent damage to structural reinforcement. Thoroughly investigate existing conditions in the vicinity of required opening prior to coring. Set sleeves prior to installation of structure for passage of pipes, conduit, ducts, etc. Protect all areas from damage.

### 3.7.9 Fire-Stop Installation Method

1. Use drop cloths to protect other surfaces when installing firestop materials.
2. If using putty around a vertical penetration, use putty to build flooring of seal, fill with fiber or rock wool to required thickness, then top with putty according to manufacturer's specifications.
3. The installation of firestop material shall incorporate methods that permit the easy removal or addition of conduits or cables without drilling or use of special tools.
4. The product shall adhere to itself to allow repairs to be made with the same material and to permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling, and resulting in a depreciated fire rating.

## 3.8 ACCESS AND ACCESS PANELS

Where Required: Provide access to materials and equipment that require inspection, replacement, repair, or service. Provide access panels and/or doors as required to allow service of all equipment components. Provide access panels where items installed require access and are concealed in floor, wall, furred space, or above ceiling. Ceilings consisting of lay-in, or removable splined tiles do not require access panels. Locations of equipment requiring access shall be noted on record drawings. Access panels shall have the same fire rating classification as surface penetrated.

### 3.8.1 Coordination

Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to the Owner.

### 3.8.2 Construction

Panels shall be at least 12 inches by 12 inches and located to provide optimum access to equipment for maintenance and servicing. Verify access panel locations and construction with the Owner and/or Owner's representative.

## 3.9 CLEANING

Cleaning shall be performed prior to commissioning. After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.

## 3.10 SPECIAL RESPONSIBILITIES AND INFORMATION

### 3.10.1 Coordination of Information

Cooperate and coordinate with work of other Sections in executing work of this Section. Perform work such that progress of entire project including work of other sections shall not be interfered with or delayed. Provide information as requested on items furnished under this Section which shall be installed under other Sections. Obtain detailed installation information from manufacturers of equipment provided under this Section.

Obtain final rough-in dimensions or other information as needed for complete installation of items furnished under other sections or by the Owner. Keep fully informed as to the shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by the work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at no expense to the Owner.

### 3.10.2 Maintenance of Equipment and Systems

Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation, and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

### 3.10.3 Use of Premises

Use of premises shall be restricted as directed by the Owner, Owner's representative and as required below:

#### 3.10.4 Cleaning and Rubbish Removal

Remove and dispose of dirt and debris and keep premises clean. During the progress of work, remove equipment and unused material. Keep the building and premises in neat and clean condition and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of the Owner and Owner's representative.

#### 3.10.5 Storage

Store materials in a manner that will maintain an orderly, clean appearance. If stored on site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks and covered with tarpaulins.

#### 3.10.6 Protection of Fireproofing

Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fireproofing work.

Conduits and other items, which would interfere with proper application of fireproofing, shall be installed after completion of spray fireproofing work.

Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by the Section responsible for damage and shall not constitute grounds for an extra to the Owner.

#### 3.10.7 Movement of Materials

Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering, and moving equipment on and around site, in building or on roof.

### 3.11 TELECOMMUNICATIONS PATHWAYS AND CABLING SUPPORT SYSTEMS

Provisions for conduits, raceways, and cable trays shall be as indicated in the project material list, project Scope of Work, and project drawings. Coordinate SCS pathway and support system work with other work and construction. There shall be no more than two (2) 90-degree sweeps or an equivalent of 180 degrees in a combination of offsets and bends per conduit home run. If additional bends are required for the home run to accommodate field conditions, provide screw cover pull boxes of appropriate size concealed above lay-in ceilings to limit the number of bends between outlets, pull boxes, and the backboard to (2) 90 degree sweeps or 180 degrees total, as specified above. All cabling shall be in raceways, cable trays or J-hook supports. Cabling is prohibited in raceways with other system wiring or power wiring. Cabling is prohibited below slab or in wet locations unless specifically indicated on the project drawings and rated for wet locations.

#### 3.11.1 J-Hook Supports

Telecommunications cables that are not placed in conduit or cable tray shall be bundled with Velcro ties and supported with J-Hooks. Coordinate J-Hook support pathways with field conditions and all other trades prior to installation. J-Hook support system must be installed prior to start of cable rough-in. J-hook cable supports shall be sized to allow for a maximum of 25% future growth to facilitate future installation of cables and installed at a maximum of 60-inches (5-ft) intervals attached to building steel or structure, when not routing in conduit or cable tray. Provide J-Hooks at every change in direction such that bends and sweeps are not sharp 90-degree turns through the J-Hook support. J-Hook support shall be installed in conveniently accessible locations. Lubricant shall not be used on cables. No portion of the cabling is to be painted for any length. Any cables that are painted shall be replaced at no cost to the Kroger/project.

Drop Ceiling Environments: The J-Hook supports shall be mounted independently from the building structure and shall not be supported from ceiling structure/framework, mechanical, electrical, fire protection or plumbing devices. Where support wires are used, independent support wires shall be attached to the structural ceiling (i.e. bar joists) on one end and to the suspended ceiling grid on the other end with *NVENT Caddy Erico part number EC3114Z34*. The prior is meant to carry the load, the latter is meant to act as a "sway control". J-Hooks shall be installed such that cable slack between J-Hook supports is a minimum of 6" above the drop ceiling. Utilize beam clamps as the method of attachment for hanging hardware. Do not drill into ceiling support structure to affix hanging hardware unless authorized by site structural engineer.

Open Ceiling Environments: The J-Hook supports shall be mounted in the area between the deck (roof) and bottom of the bar joist with no supports or cable pathway below the bottom of the bar joist.

### 3.12 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

Horizontal distribution cabling shall be installed in accordance with contract documents, NEC, and manufacturer's instructions. All cables damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner. Horizontal cabling shall terminate in a telecommunication

space on the same floor as the outlet, and shall not extend between floors, unless indicated or specified otherwise in the project drawings.

#### 3.12.1 Lengths

Horizontal cables shall be continuous, with no factory or field splices with the total length of each cable not to exceed 295-feet (90 meters) from the work area outlet location to the termination point in the telecommunications space.

A 10-foot service loop for each cable shall be coiled neatly in a figure eight pattern and stored in the ceiling/overhead above the outlet, provided the 295-ft (90 meters) cable distance limit is not exceeded. Excess cable slack shall be pulled out of the box, not twisted and crammed into the box when installing the faceplate.

#### 3.12.2 Installation

Provide the appropriate complement of copper horizontal cables from each work area outlet location to the assigned telecommunications spaces as indicated on the project drawings. Each copper horizontal cable shall be identified with a white self-laminating machine-generated label on both ends of the cable containing the CABLE ID per Kroger Labeling standard. All horizontal cables terminated within the same faceplate must be routed to and terminated in the same telecommunications space. Provide faceplates, surface mount boxes and modular jacks at each work area outlet location as required for the environment being installed. Place blank covers in the unused opening on each faceplate and each surface mount box matching the color of the faceplate or surface mount box.

The cable's maximum pulling tension and bend radius as published by the manufacturer shall not be exceeded during placement. In no case shall pulling tension exceed 25 pounds (111 Newtons). Horizontal distribution cables shall be neatly bundled in groups not greater than 24 cables with Velcro and other hook and latch style cable ties.. Do not allow deformation of the bottom cables within the bundle. Cabling shall have no bends less than four times the cables outside diameter at any point in the run and at the termination locations unless the manufacturer's instructions are more stringent. If the cables are kinked during installation, the cable shall be removed and replaced with new cables at no additional cost to the Owner. All outlet locations shall be coordinated with nearby 120 VAC receptacles and related devices. Install cabling to prevent stress on cabling system and adverse effect on performance caused by:

1. Cable twisting or kinking during pulling or installation.
2. Tension caused by suspended cable runs.
3. Tightly cinched cable ties (use Velcro straps). Use of cable ties is not permitted.
4. Exceeding the minimum allowable cable bend radius

Horizontal cables exiting power poles shall be concealed in solid or split corrugated loom tubing, appropriately sized.

#### 3.12.3 Raceways and J-Hook Support Pathways

Install complete cable tray system and J-Hook support system before starting installation of horizontal cabling. Installation of horizontal cable before completion of cable tray and J-Hook support system is not permitted.

The horizontal cable pathways shall route in cable tray and/or J-Hook support system, parallel and perpendicular paths to building lines and turn at 90-degree angles (provide necessary hardware to maintain proper bend radius at corners) maintaining minimum bend radius for the specified cable. Horizontal cable pathways shall not be routed underneath sprinkler pipes and shall not be lower than the bottom of the bar joist in an open ceiling environment while maintaining proper clearances from EMI sources per code and industry standards.

J-Hook supports shall be appropriately sized with future growth with supports installed 5-feet or less intervals attached to the building steel or structure, when not routing in conduit or cable tray. The J-Hook support system shall be mounted independent from the building structure and shall not be supported from the ceiling structure/framework, mechanical, electrical, fire protection or plumbing devices.

Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type, unless more stringent requirements are specified or indicated. Conduits and other raceways shall be routed in a manner to achieve the maximum length limitation specified above. The pathway and raceway system shall be complete from the telecommunications outlet boxes to the telecommunications rooms, including firewall penetration sleeves, prior to installation of cabling. Pull boxes shall be installed in conduit pathways after every two 90-degree bends or 100 ft of cable routing. Sleeves of the quantity and type indicated shall be used where cables penetrate fire or smoke rated walls and floors. A bonding jumper shall be routed through sleeves to connect sections of cable trays at firewall penetrations.

#### 3.12.4 Supports

Cable shall be installed above fire-sprinkler and all other systems and shall not be attached to the system or any ancillary equipment or hardware. The cabling system and support systems shall be installed so that it does not obscure any valves, fire protection conduit, boxes, or other control devices. Cables and conduits shall have an independent means of support and shall not be attached to ceiling grid or lighting fixture support wires. Provide Velcro cable ties in closets and cable trays for cable management and bundling of cables. Cabling and supports/raceways shall not be supported from electrical conduits, sprinkler systems, or other utility system pipes.

#### 3.12.5 Terminations

All copper horizontal cables shall be terminated on modular jacks on each end of the cable utilizing the T568B wiring scheme. Terminating one cable on more than one jack module is not allowed. Copper horizontal cable jacket removal and cable pair untwisting for termination shall not exceed limits specified by the cabling system manufacturer and the applicable standards.

All copper horizontal cables shall be terminated to not induce tension on the terminating equipment.

Splicing or bridged taps of SCS cabling shall not be permitted except where specifically indicated or specified for telecommunications outlets where appropriate for the telecommunications devices connected. Mechanical couplers or splices shall not be permitted except where specifically specified or indicated for telecommunications device connections. Dress cable to final location, remove sheath to point allowing splaying of conductor, and terminate. Make each termination uniform and precise. Do not attempt to restore, modify, or add to manufacturer's twisting of cable.

#### 3.12.6 Surge Protective Device (SPD)

Horizontal cable PoE surge protectors, Category 6, shall be installed for all applications where a single 4-pair category cable serves an outlet outside the footprint of the building (i.e. an emergency telephone, exterior wireless access point or exterior IP security camera) to provide overvoltage protection on cabling exposed to lightning or accidental contact with power conductors. Surge protectors shall be certified up to Category 6 cable performance, including power-over-ethernet applications and be UL Listed. Bond and ground surge protector per manufacturer's installation specifications.

#### 3.12.7 Separation from Electrical Wiring

Crossings of SCS communications cables with line voltage (120VAC and higher) electrical cables shall be at 90 degrees only. Separate communications cables from other cables and fixtures minimum distance as follows:

1. Electrical Cables in magnetic steel conduit: 6-inches
2. Fluorescent Light Fixtures: 6-inches
3. Electrical motors, generators, or transformers: 48-inches

#### 3.12.8 Identification

Comply with paragraph "Labeling and Administration" in this section.

### 3.13 TELECOMMUNICATIONS OUTLET INSTALLATION

Cables shall be installed and terminated in accordance with the recommendations made in the specified standards and the manufacturer's instructions. Comply with requirements specified hereinafter for UTP pair untwist limits and UTP cable jacket removal limits. The bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable, unless a larger bend radius is recommended by the manufacturer.

#### 3.13.1 Connection Style

Modular jacks shall be wired to the T568B wiring scheme.

#### 3.13.2 Slack

Horizontal cables shall have a minimum of 36-inches of slack on both ends unless cable distance limitations are exceeded. Excess cable slack shall be neatly coiled and stored above each work area outlet, on the cable runway in constructed telecommunications spaces and inside or outside enclosures in an open bay or outdoor environment.

#### 3.13.3 Jack Module Positions in Faceplates

Refer to project drawings for jack module placement within each faceplate configuration.

### 3.14 EQUIPMENT RACKS, CABINETS AND ENCLOSURES

Refer to paragraph "General Installation Requirements" above for additional requirements. Install racks, cabinets, and enclosures in the following manner:

1. Shall be supplied with vertical and/or horizontal cable management as detailed in the project drawings.

2. Shall be labeled to identify the equipment rack, cabinet, or enclosure with the telecommunications space identification.
3. Tie to the wall via the ladder cable runway indicated for routing.
4. Securely attach to the concrete floor using concrete expansion anchors.
5. Wall-mount enclosures shall be securely anchored to the wall or other surfaces using the hardware specified by the manufacturer and per the manufacturer installation specifications to support the enclosure's maximum load. Ensure the operation of the hinged wall-mount enclosure swing is not obstructed.
6. Cable runway to support the rack row and used for cable routing in telecommunications spaces including cable runway accessories and grounding components as indicated on the project drawings.
7. Network equipment and components layout in rack, cabinets and enclosures shall follow the configuration shown on the project drawings.
8. Network equipment placement in racks, cabinets and enclosures shall be coordinated with Kroger Distributed Networks.

#### 3.14.1 Grounding

Comply with grounding and bonding system requirements specified in this specification section and indicated in the project material list, project Scope of Work, and project drawings.

Rack mount screws and/or cage nuts not used for installing devices and other hardware shall be bagged and left with the rack upon completion of the installation.

### 3.15 ENCLOSURES

Refer to paragraph "General Installation Requirements" above for additional requirements. All cabinets, boxes, and similar enclosures containing system components and/or cabling and which are easily accessible to employees or to the public shall be provided with a key lock and spare keys to be furnished to the Owner. Boxes above ceilings in occupied areas of the building shall not be considered to be accessible, unless specified or indicated otherwise. All junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamper proof screws or keyed lock. Provide all necessary interconnections, services, and adjustments required for a complete and operable system as specified.

#### 3.15.1 Exterior Locations

Provide weatherproof equipment and wiring methods for wet locations and areas exposed to weather, in accordance with the project material list, project Scope of Work, project drawings, manufacturer's instructions, and applicable industry standards.

#### 3.15.2 Wiring within Enclosure

Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure to approved termination provisions. Mark each terminal according to the wiring diagrams of the system. Make all connections with approved methods.

### 3.16 PATCH PANELS

Refer to paragraph "General Installation Requirements" above for additional requirements. Patch panels shall be mounted in the equipment racks, cabinets or enclosure indicated. Comply with manufacturer's instructions, the project material list, project Scope of Work, and project drawings for installation.

### 3.17 CROSS-CONNECT INSTALLATION

Refer to paragraph "General Installation Requirements" above for additional requirements.

#### 3.17.1 Copper Terminations

Cables shall be neatly bundled and dressed to their respective termination panels. Based on patch panel density, individual bundles of 24 cables shall be routed and neatly dressed.

#### 3.17.2 Fiber Optic Terminations

Fiber optic enclosure housings, panels and trays shall provide adequate cable management accessories to properly strain relief, dress, provide slack storage, and protect fiber cable and fiber strands to the termination. Fiber slack shall be neatly coiled within the fiber optic enclosure housing/tray. No slack loops shall be allowed external to the fiber optic enclosure housing/tray(s). Each cable shall be individually attached to the respective termination panel by mechanical means. The cables strength member(s) shall be securely attached to the cable strain relief bracket in the enclosure housing/tray. Each



fiber cable shall be stripped upon entering the enclosure housing and the fibers routed to the termination panel. Dust caps shall always be kept on fiber connectors and couplings unless they are in use and physically connected.

#### 3.17.3 Identification

All horizontal and backbone cables shall be clearly labeled at the termination panel 4 inches from termination point. All fiber optic cables shall be clearly labeled at the entrance to the fiber optic enclosure/panel. Comply with paragraph "Labeling and Administration" in this section.

### 3.18 SERVICE ENTRANCE

Refer to paragraph "General Installation Requirements" above for additional requirements. Provide conduits for the routing of the access provider (AP) service cable(s) from the location indicated on the project drawings to the entrance facility (EF) location. The service entrance conduit installation shall comply with all contract documents and AP/telephone company requirements.

### 3.19 BACKBONE CABLE INSTALLATION

Refer to paragraph "General Installation Requirements" above for additional requirements. Backbone voice and data cables shall be terminated on the cross connects specified/indicated on the project drawings and in the project specifications. All backbone cables shall be installed in the following manner:

1. Perform all backbone cable installation in conformance with manufacturer's installation guidelines. Ensure that maximum pulling tensions of specified cables are not exceeded and cable bends maintain the proper radius during placement.
2. Cable tray and J-Hook supports shall be installed prior to installing any backbone cables.
3. Backbone cable pathways shall route in cable tray and/or J-Hook support system and in route parallel and perpendicular paths to building lines and turn with sweeping 90-degree angles maintaining minimum bend radius for the installed cable. Backbone cable pathways shall not be routed underneath sprinkler pipes.
4. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.
5. Provide new pull-rope through all conduit while pulling in the backbone cable.
6. Where backbone cables and horizontal distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables. Refer to additional requirements indicated on the project drawings and in the project specifications.
7. Fiber optic cables shall not be spliced without prior written approval of the Owner and Owner's Representative.
8. Mount backbone termination panels in racks, cabinets and enclosures as indicated on the project drawings.
9. Terminate backbone cables so that the cables do not incur tension on the terminating equipment.
10. Permanently label all backbone cables with the cable number at both ends, no further than 4-inches from the removed cable sheath.
11. Provide a minimum 10-foot service loop on both ends of each backbone cable.
12. Do not roll or store cable reels without appropriate floor protection.
13. Test and label the backbone installation.
14. Red-line (document) the final backbone installation on the as-built drawings.
15. Failure to follow appropriate guidelines for backbone cable installation and damage sustained during installation will require the Contractor to provide, in a timely manner and fashion, the additional material and labor to rectify the situation.

### 3.20 PATHWAY AND RACEWAY INSTALLATION

1. Rigid steel and IMC conduit fittings shall be made wrench-tight with threaded couplings and with full threads employed in the fitting. EMT conduit fittings shall be made wrench tight. Conduit and tubing shall be the type and sized as indicated on the project drawings. Where sizes are not indicated, comply with NEC and all referenced standards as a minimum.
2. All conduits shall be square cut and reamed to remove any shoulders. The ends of the conduit shall be reamed and bushed. Bends and offsets shall be made with standard conduit ells. Field bends shall be made with an approved bender or hickey or hub-type conduit fittings. The maximum allowable number of bends between pull boxes and enclosures shall conform to NEC, provide additional pull boxes where indicated.
3. Conduits shall be neatly arranged, properly aligned, and supported. Conduit shall be kept at least six (6) inches from flues, steam pipes or hot water pipes where possible. Exposed conduits shall be run parallel to and at right angles to building lines. Run concealed conduits in a direct line with long sweep bends and offsets.



4. Conduits shall be free from obstructions, cleaned and dry before pulling conductors. The Contractor shall exercise necessary precautions to prevent dirt, plaster or trash in conduit, fittings, and boxes during installation. All conduit ends shall be plugged with approved conduit seals as soon as installed and shall not be withdrawn until all concrete work, masonry work and plastering are complete.
5. Conduits shall be mechanically and electrically continuous between outlets, equipment, and pull or junction boxes. Maintain ground continuity by providing locknuts inside and outside of all connections to panels, cabinets, gutters and boxes for rigid conduit and IMC. Provide one inside locknut and one outside fitting for all EMT connections. Where conduits are installed across building expansion joints, appropriate expansion fittings shall be provided.
6. Conduits ending into a cable tray shall be no more than 6-inches from the cable tray.
7. Penetrations: Penetrations shall be provided where required, with all work necessary for maintaining the fire ratings of the walls and floors to be penetrated. Provide UL listed firestopping systems selected for the specific installation as required to comply with all applicable codes and requirements of the Authority Having Jurisdiction (AHJ) in maintaining the fire ratings of walls and floors. Comply with additional requirements as indicated on the project drawings and in the project specifications.
8. PVC conduit joints shall be watertight using solvent cement manufactured by the conduit manufacturer for the application.
9. Conduit Supports and Anchors: Comply with NEC as a minimum, except where more stringent requirements are specified below:
  - a. Rigid Galvanized Conduit (RGS), Intermediate Metal Conduit (IMC), and electrical Metallic Tubing (EMT): anchor within three feet of all outlet boxes, junction boxes, cabinets, gutters, or fittings. Horizontally anchor at 10-foot maximum intervals.
  - b. Rigid Nonmetallic Conduit (PVC Schedule 40): anchor within three feet of all outlet boxes, junction boxes, cabinets, gutters, or fittings and bends or turns. Horizontally anchor at 10-foot maximum intervals.
  - c. Flexible metal conduit: anchor within 12 inches of all outlet boxes, junction boxes, cabinets, gutters, or fittings and bends or turns. Horizontally anchor at 4 ½ foot intervals.

### 3.21 INSTALLATION OF PULLBOXES, JUNCTION BOXES AND WIREWAYS

Provide pull boxes, junction boxes and wireways where indicated or necessary on the project drawings in the raceway system to facilitate conductor installation. Conduit runs with more than three right angle bends shall have a pull box installed at appropriate intermediate location. No section of continuous conduit shall be longer than 100-ft between pull boxes. The inside radius of a conduit bend shall be at least 10 times the conduit internal diameter. Bends in conduit shall not contain any kinks or other discontinuities that may have a detrimental effect on the cable sheath during cable pulling operation. Locate and provide pull boxes such that the maximum pulling tensions, as specified by cable manufacturer(s), are not exceeded.

#### 3.21.1 Mounting

Boxes and wireways shall be mounted to the building structure with supporting facilities independent of the conduits entering or leaving. In no case shall boxes or wireways be installed in inaccessible locations. Boxes recessed into walls and ceilings shall be flush with the finished surface. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes with the casework construction.

#### 3.21.2 Sizing

Boxes and wireways shall be sized in accordance with NEC, unless larger sizes are indicated or specified in the project drawings. Boxes and wireways shall be U.L. listed. All unused openings in boxes and wireways shall be effectively closed to afford protection substantially equivalent to that of the wall of the box or fitting.

#### 3.21.3 Boxes within Rated Walls or Partitions

Comply with all applicable codes and requirements of the Authority Having Jurisdiction (AHJ). The surface area of individual metallic boxes shall not exceed 16 square inches. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet. Boxes located on opposite sides of walls or partitions shall be separated by a horizontal distance of at least 24 inches. Metallic boxes shall be securely fastened to the studs and the opening in the wall board facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 inch.

#### 3.21.4 Identification

Junction boxes concealed above ceilings shall be marked with a permanent marker in 1-inch-high lettering to indicate the telecommunications cabling system(s) contained within the box.

### 3.21.5 Inaccessible Ceiling Areas

Install outlet and junction boxes no more than 6 inches from ceiling access panel.

## 3.22 SUPPORTING DEVICE INSTALLATION

Install supporting devices to fasten pathways, raceways, cabling, equipment, devices, and components securely and permanently in accordance with NEC requirements. Coordinate with the building structural system, mechanical piping, ductwork, equipment, and with other electrical work. Fabricate supports from structural steel angle or structural steel channel. Rigidly weld members or use hexagon bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts. Provide seismic bracing where required in accordance with applicable codes, constructed as required by manufacturer's instructions and applicable codes. Install surface-mounted cabinets and enclosures with a minimum of four anchors. Properly support and anchor equipment pathways, raceways, and cabling in accordance with the project Scope of Work, project drawings, and manufacturer's instructions. Anchor floor mounted equipment to floor. Mount equipment designed for wall mounting to wall or steel strut support assembly, suitable for the equipment to be supported. Reinforced walls and steel struts where required for the equipment provided.

### 3.22.1 Suspended Ceilings

For raceways, pathways, and cabling located above suspended ceilings, provide an independent means of secure support in accordance with NEC, separate from ceiling support system. Support single conduits and boxes with drop wires or threaded rods. Support multiple conduits with steel strut trapeze and threaded rods.

### 3.22.2 Supports

Raceways and cables shall be secured and supported in accordance with the NEC unless closer support spacing is specified or indicated. Raceways and cables shall be secured and supported directly from the building structure; support from other raceways, conduits, ceiling support wires, or ceiling grid shall not be permitted. Provide an independent means of secure support in accordance with the NEC. Cables not specified or indicated to be in raceway or cable tray shall be supported and secured with "J"-Hooks. Perforated iron straps, threaded bridle rings, cable clamps and "tie-wraps" shall not be permitted as cable support devices. Raceway, pathway, and cable support installation shall comply with the following requirements:

1. Conform to NEC and manufacturer's recommendations for selection and installation of supports. Anchor and fasten supports and their related hardware securely to the building structure or ceiling/wall assemblies of adequate structural rating for the loads imposed.
2. The strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers fabricated from threaded rods and u-channel strut.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways above accessible suspended ceilings only. For hanger rods with spring steel fasteners, use 3/8 inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceways in accordance with NEC and manufacturer installation guidelines.
7. Support exposed and concealed raceway within 12 inches of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported, and raceway terminals are not made with chase nipples or threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed cabling is carried entirely by the conduit supports and cable supports with no weight load on cable terminations.
9. Vertical Conductor Supports: Install simultaneously with installation of conductors.
10. Miscellaneous Supports: Support miscellaneous electrical components as required producing the same structural safety factors as specified for raceway supports. Provide steel channel strut where required to facilitate mounting and anchoring of cabling, pathways, and raceways.
11. In open overhead spaces, support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

12. Sleeves: Install in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated wall or floor construction, provide firestopping in accordance with all applicable building codes, NEC, and as specified in Section "Fire Stop System".
13. Conduit Seals: Provide seals for conduit penetrations of slabs on grade and exterior walls below grade; provide at additional locations where indicated or required for the installation.

#### 3.22.3 Anchors and Fasteners

Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units and gypsum board partitions/ceilings; concrete inserts or expansion bolts on concrete or solid masonry; and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge shall not be used. Plastic or nylon insert anchors, nails, and driver anchors shall not be used. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws. Holes in reinforced concrete beams or in concrete shall not cut the reinforcing bars. Fill holes that are not used. Do not exceed 25 percent of proof test load for loads applied to fasteners. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

#### 3.22.4 Expansion Provisions

Provide expansion fittings in conduits where required to accommodate a building and/or conduit expansion, including but not limited to locations where conduits cross expansion joints. Provide additional fittings at the locations indicated.

### 3.23 CABLE TRAY INSTALLATION

Install cable tray level and plumb according to manufacturer's written instructions, coordination drawings, original design, and referenced standards. The cable tray support system must be installed prior to start of cable rough-in. The cable tray system shall be field fabricated in direction and elevation by cutting and bending the cable tray. Cable tray wires must be cut with side-action bolt cutters with offset head to ensure integrity of protective galvanized layer. Remove burrs and sharp edges from the cable trays. Fasten cable tray supports securely to building structure. Coordinate cable tray with field conditions and other work as necessary to properly interface installation of cable tray work with all other work. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables. Unless a greater clearance is indicated or specified elsewhere, provide the following minimum clearances:

1. Ceiling Grid Environment: between 3-inch (minimum) to 12-inch clearance above the ceiling grid dependent on ceiling space height
2. Top: 12 inches minimum headroom above the cable tray
3. One side: 12 inches minimum on at least one side of the cable tray

#### 3.23.1 Cable Tray Supports

Support cable tray with manufacturers supports and accessories mounted to the building structure independent of other support structures or mechanical equipment using the trapeze method, center hung method, and/or vertically mounted method. Include manufacturers components and compatible fittings for a fully installed electrically continuous system. Locate and install supports no more than 6 feet apart, unless a closer spacing is specified or indicated. Provide additional support where specified, indicated, or required by field conditions. Wall-mounted cable trays shall use the manufacturer's triangular-style wall brackets. Center hung cable tray supports shall not be permitted unless specifically indicated or specified on the project drawings. Conform to NEC and manufacturer's recommendations for selection and installation of supports. The strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support. Provide U-bolts, clamps, anchors, attachments, and other hardware necessary for hanger assembly and for securing hanger rods. Overhead supports shall use 3/8" minimum diameter threaded rods and necessary hardware and shall be the standard product of the cable tray manufacturer approved for the installation or may be constructed from steel strut trapeze and 3/8" minimum diameter threaded rods. Install the cable tray system with supports independent of piping, ductwork, and conduit systems. Coordinate installation with all piping and other work and arrange to provide full access to the tray throughout runs. Provide horizontal and vertical tray supports with adequate bearing surface for the tray with provision for hold down clamps or fasteners. Provide vertical tray supports having secure means for fastening cable trays to supports.

#### 3.23.2 Supports

The runway should be supported as indicated on the project drawings with 3/8-inch minimum diameter threaded rod, applicable support brackets or by attachment to telecommunications system racks with runway manufacturer's attachment accessory.

### 3.23.3 Connections

Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independently of fittings. Do not carry the weight of cable tray on equipment enclosures.

### 3.23.4 Accessories

Install at locations specified, indicated, or required on the project drawings for the installation. Fasten to the cable tray system with appropriate hardware.

### 3.23.5 Fire Stop

Cable tray system shall not be continued through a fire-rated wall. Stop the cable tray 6-inches from the fire-rated wall and install *STI EZ Path firestop assemblies* or *STI Fire Stop Ready Sleeve Kit of equal capacity* then continue cable tray on the other side of the fire-rated wall. Ensure the cable tray ground is continuous through the fire-rated wall.

Comply with requirements indicated in this specification.

### 3.23.6 Fittings

Provide tees, crosses, risers, elbows, and other fittings as indicated on the project drawings, of same materials and finishes as cable tray. Provide fittings to accomplish all changes in direction and changes in width of tray systems. Provide drop-out fittings where indicated, specified, or required, with minimum radius determined by cable bending radius criteria for cables provided, unless indicated or specified otherwise.

### 3.23.7 Connectors

Provide connectors to join components to form a continuous system without structural weakness at joints. Connectors shall be bolted or clamped and of the rigid, hinge, expansion, or adjustable type. Use connectors that provide electrical continuity in accordance with NEMA VE 1 connection test requirements. Provide continuous ground conductors as indicated on cable tray schedule, bonded to every cable tray section and every tray connector fitting.

### 3.23.8 Covers

Provide type indicated, of the same material and finish as the tray. Install covers after installation of cable is completed. Fasten cover to tray using double clamp type cover attachments, coordinated with cover construction (flat or peaked). Do not use attachments requiring welding or drilling for use. Do not use attachments with screws, bolts or other projections that protrude into the cable space. Cover clamps shall be compatible with cable tray.

### 3.23.9 Cable Fasteners

Secure cables to cable tray rungs in accordance with the cable manufacturer's recommendations for horizontal and vertical sections of cable tray. Secure cables with Velcro cable ties. Velcro cable ties for SCS cabling shall be loosely fastened to prevent deformation of the cable insulation and jacket. Velcro cable ties shall be loose enough to rotate on the cable bundle and loose enough to slide longitudinally.

### 3.23.10 Cabling System Separation

Provide barriers to separate cables of different systems and voltage classes. Cable trays are reserved for low voltage cabling related to the Telecommunications SCS, unless specifically indicated or specified otherwise on the project drawings and project specifications.

### 3.23.11 Cable Tray Expansion Fittings

Anchor cable tray in accordance with manufacturer's instructions between expansion connectors. Locate connectors and set gaps according to NEMA VE 1 for areas having ambient temperature excursions greater than 50 degrees F between minimum and maximum temperature unless more stringent spacing requirements are specified below. Provide expansion connectors or manufacturer-approved provision for expansion and contraction where cable tray crosses building expansion joints and at the following intervals:

1. Interior locations: 90 foot maximum spacing
2. Exterior locations: 60 foot maximum spacing
3. All locations: Where recommended or required by the cable tray manufacturer.

### 3.23.12 Ceiling Tiles

Ceiling tiles shall be removed as necessary for the cable tray installation and put back in place without damaging any of the tiles or support framework. The Contractor is responsible for the cost to repair or replace damaged ceiling tiles or framework.

### 3.23.13 Grounding

UL Classified cable trays (including painted trays) may act as an equipment grounding conductor. Use UL Classified splicing methods to ensure cable tray is electrically continuous and bonded as recommended by the manufacturer.

1. Ground cable tray at end of continuous run.
2. Ground continuous cable tray runs every 60-feet.
3. Ground cable trays by mounting ground straps or grounding clamps to each section of the cable tray system.

Comply with additional grounding and bonding requirements specified in this section.

### 3.23.14 Protection

Provide final protection and maintain conditions to ensure cable tray is without damage or deterioration at the time of Substantial Completion. Repair damage to galvanized finishes of tray and fittings with zinc-rich paint recommended by cable tray manufacturer. Repair damage to PVC coatings and paint finishes of tray and fittings with matching touchup coating recommended by cable tray manufacturer.

## 3.24 GROUNDING AND BONDING SYSTEM (GBS) INSTALLATION

Install GBS and equipment in locations as indicated, according to manufacturer's written instructions, applicable codes, project material list, project Scope of Work, and project drawings. Install grounding systems where shown, in accordance with applicable portions of NEC and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions. Grounding and bonding conductors shall be routed as directly as practical; conductor lengths shall be no longer than necessary. Conductors shall be concealed where practical below raised floors or above suspended ceilings.

Route grounding conductors as indicated along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage. The minimum bending radius for grounding conductors outside of raceway systems shall be 8 inches; kinks and sharp bends shall not be permitted.

Install grounding and bonding system (GBS) conductors in raceway systems unless otherwise indicated or specified. GBS conductors shall be spliced only in outlet boxes, junction boxes, pull boxes, and ground buses. Splicing shall be kept to an absolute minimum and only where necessary for connections or approved by the Owner's representative. Splices in raceways and cable tray shall not be permitted, except where specifically indicated or specified on the project drawings and the project Scope of Work.

### 3.24.1 Ground Connection – General Requirements

Provide system ground connections as indicated on the grounding plans, grounding riser diagrams, and grounding detail drawings. Make connections in such a manner as to prevent galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so that metals in direct contact will be galvanically compatible. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series. Make connections with clean bare metal at points of contact.

### 3.24.2 Dissimilar Material Connections

1. General: Coat and seal connections involving dissimilar metals with a protective paint to prevent future penetration of moisture to contact surfaces. Avoid dissimilar material connections unless absolutely necessary.
2. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps.
3. Aluminum to galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
4. Aluminum to copper connections shall be with stainless steel separators and stainless-steel clamping hardware. Products designed for aluminum-copper connections may be used where NRTL-listed for the application and approved in writing by the Owner and Owner's representative.

### 3.24.3 Connections

Terminate grounding and bonding system (GBS) conductors with the connection devices specified. Install connection devices in accordance with the manufacturer's instructions, NEC requirements, and additional requirements of this section.

1. Connection torque values: Tighten wiring connectors, terminals, bus joints, and mountings, including lugs, screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where the manufacturer does not publish connection or terminal torque values, comply with the torque values specified in UL 486A and UL 486B.
2. Exothermic Welded Connections: Provide where indicated or specified, and in accordance with manufacturer's instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not

acceptable. Coat exothermic welds to galvanized surfaces with field-applied cold galvanizing compound. Use molds and equipment appropriate for the connection type and conductor size.

3. Compression Lug Connections: Provide in accordance with manufacturer's instructions. Use lugs and compression tools with dies that are appropriate for the connection type and conductor size.
4. Mechanical Clamp Connections: Provide in accordance with manufacturer's instructions. Use lugs and accessories that are appropriate for the connection type and conductor size.

#### 3.24.4 Metal Raceways

All metal raceways, including but not limited to, conduit, surface metal raceway, wireway, and cable tray, shall be grounded and bonded in accordance with the project material list, project Scope of Work, and project drawings and the manufacturer's instructions. Comply with additional requirements specified or indicated.

#### 3.24.5 Bonding of Cable Trays

Cable tray sections shall be securely bonded together and electrically continuous. Provide a continuous stranded bonding conductor for the entire length of the cable tray, bonded to each cable tray section and fitting with a cable tray compression clamp; extend bonding conductor to the facility ground system at each end of the cable tray system and at intervals not exceeding 100 feet. Cable tray-bonding conductors shall be the sizes and types specified or indicated for the cable tray system. Comply with additional requirements indicated or specified.

#### 3.24.6 Equipment Ground Conductors and GBS Conductors in Raceway

Bond metallic conduits at both ends with grounding bushings and grounding conductor jumpers to the nearest telecommunications ground bus or the enclosed ground conductor.

#### 3.24.7 Identification

Comply with specification requirements in this section.

#### 3.24.8 Testing

Conduct testing to verify bonding continuity and low-impedance connections to the facility ground system for the following equipment:

1. Facility ground electrode system
2. Primary Bonding Busbar (PBB)
3. Secondary Bonding Busbar (SBB)

#### 3.24.9 Grounding and Bonding System Continuity Testing

Test the following equipment for continuity equipment to connection with facility ground system; submit test reports with measured resistances between equipment and to facility ground system:

1. Secondary Bonding Busbar (SBB); measured from each SBB to the PBB.
2. Primary Bonding Busbar (PBB); measured from the PBB to the point of connection with the facility ground system and the main electrical service ground bus.
3. Acceptable GBS measurements are as follows:
  - a. Resistance:  $\leq 0.1$  ohms
  - b. AC Current:  $< 1.0A$

### 3.25 FIRE STOP SYSTEM INSTALLATION – GENERAL REQUIREMENTS

Fire stop systems shall be provided where required, with all work necessary for maintaining the fire ratings of the walls and floors to be penetrated. Provide UL listed firestopping systems selected for the specific installation as required to comply with all applicable codes and requirements of the Authority Having Jurisdiction (AHJ) in maintaining the fire ratings of walls and floors. Comply with additional specification requirements indicated in the project Scope of Work and on the project drawings. Comply with product manufacturer's instructions and additional requirements indicated or specified herein. Comply with all applicable state and local codes, Life Safety Code and National Electrical Code. Firestopping shall be provided as a system for all penetrations of smoke and fire-rated walls, partitions, floors, and ceilings, to maintain the fire resistance ratings and performance ratings required by the codes and standards specified above. Comply with all requirements of the Authority Having Jurisdiction. (AHJ). Install firestopping systems for the SCS and equipment in locations as indicated, according to manufacturer's written instructions.

#### 3.25.1 Coordination

Coordinate construction openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements. Coordinate sizing of sleeves, opening, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

Install firestopping systems for the SCS and equipment to provide required maintenance and code working clearance for servicing and maintenance. Coordinate final location of concealed pathways, raceways, and equipment requiring access with final location of required access panels and doors. Allow required space for removal of parts that require replacement or servicing.

#### 3.25.2 Standards

Comply with requirements specified in this section and all details included on the project drawings and in the project Scope of Work. Comply with product manufacturer's instructions and additional requirements indicated or specified herein. Comply with all applicable state and local codes, Life Safety Code and National Electrical Code. Firestopping shall be provided as a system for all penetrations of smoke and fire-rated walls, partitions, floors, and ceilings, to maintain the fire resistance ratings and performance ratings required by the codes and standards specified above. Comply with all requirements of the Authority Having Jurisdiction. (AHJ).

#### 3.25.3 Selection and Application

Select firestopping systems appropriate for the penetration/structure application and shall be a listed (UL and/or FM) firestopping assembly system tested. The assembly size and quantity shall be determined as follows:

1. For round openings, the fill ratio of cabling-to-opening-size shall not exceed 40% or as dictated by the manufacturer, whichever is more stringent.
2. For rectangular openings, the fill ratio of cabling-to-opening-size shall not exceed 50% or as dictated by the manufacturer, whichever is more stringent.
3. Include in cabling cross-sectional area enough spare capacity to accommodate 50% growth. Upon commissioning, if adequate spare capacity is not observed, the Contractor shall install additional assemblies at their own cost to provide such spare capacity.

#### 3.25.4 Installation

Comply with manufacturer's instructions, all applicable building codes and NEC, and the requirements specified herein. Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design. Comply with manufacturer's instructions for installation of firestopping products.

#### 3.25.5 Project Conditions

Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by the manufacturer. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes. Do not use materials that contain flammable solvents. Do not proceed until unsatisfactory conditions have been corrected.

Maintain minimum temperature before, during, and for a minimum of 3 days after installation of materials. NOTE: Firestop system must be installed BEFORE freezer and cooler areas are brought down to temperatures for proper firestop system curing.

#### 3.25.6 Surfaces

Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion. Provide masking and temporary covering to protect adjacent surfaces.

#### 3.25.7 Application Temperature

Maintain minimum temperature before, during, and for a minimum of 3 days after installation of materials.

#### 3.25.8 Coordination

Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.



### 3.25.9 Scheduling

Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

## 3.26 TESTING, IDENTIFICATION and ADMINISTRATION OF BALANCED TWISTED PAIR INFRASTRUCTURE

### 3.26.1 SCOPE

This section includes the minimum requirements for the test certification, identification, and administration of horizontal balanced twisted pair cabling.

- Copper cabling test instruments
- Copper cabling testing
- Administration (test results documentation)

Testing shall be carried out in accordance with this document.

Testing shall be performed on each cabling link. (100% testing)

All tests shall be documented.

### 3.26.2 QUALITY ASSURANCE

All testing procedures and field-test instruments shall comply with applicable requirements of:

- ANSI/TIA-1152-A, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- ANSI/TIA-568-D.0, Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568-D.1, Commercial Building Telecommunications Cabling Standard
- ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including requirements specified by the customer, unless the customer specifies their own labeling requirements.

Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

- Manufacturer of the connectors or cable
- Manufacturer of the test equipment used for the field certification.
- Training organization (e.g., BICSI, Association of Cabling Professionals [ACP])

The Owner and/or the Owner's representative shall be invited to witness and/or review field-testing.

- The owner and/or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.

### 3.26.3 ACCEPTANCE OF TEST RESULTS

Unless otherwise specified by the Owner or the Owner's representative, each cabling link shall be tested for:

- Wire Map
- Length
- Propagation Delay
- Delay Skew
- DC Loop Resistance – recorded for information only.
- DC Resistance Unbalance – recorded for information only.
- Insertion Loss
- NEXT (Near-End Crosstalk)
- PS NEXT (Power Sum Near-End Crosstalk)
- ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only.
- PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only.
- ACR-F (Attenuation to Crosstalk Ratio Far-End)
- PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- Return Loss
- TCL (Transverse Conversion Loss) – recorded for information only.
- ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only.



All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation provided to the Owner or Owner's representative prior to final acceptance.

#### 3.26.4 PRODUCTS

The field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.

Certification Tester:

- Accuracy
  - Level IV accuracy in accordance with ANSI/TIA-1152-A
  - Independent variation of accuracy
  - Acceptable manufacturers
    - Fluke Networks
- Permanent Link Adapters
  - RJ45 plug must meet the requirements for NEXT, FEXT, and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
  - Twisted pair Category 5e, 6, 6A, 7 and 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- Results Storage
  - Must be capable of storing >10,000 results for all measurements found below:
    - Wire Map
    - Length
    - Propagation Delay
    - Delay Skew
    - DC Loop Resistance – recorded for information only.
    - DC Resistance Unbalance – recorded for information only.
    - Insertion Loss
    - NEXT (Near-End Crosstalk)
    - PS NEXT (Power Sum Near-End Crosstalk)
    - ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only.
    - PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only.
    - ACR-F (Attenuation to Crosstalk Ratio Far-End)
    - PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
    - Return Loss
    - TCL (Transverse Conversion Loss) – recorded for information only.
    - ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only.
    - Time Domain Reflectometer
    - Time Domain Xtalk Analyzer
- PC Software
  - Windows® based.
  - Must show when 3dB and 4dB rules are applied.
  - Re-certification capability, where results must have their Cable IDs suffixed with (RC)
  - Built in PDF export – no additional third-party software permitted.
  - Built in statistical analysis.

#### 3.26.5 EXECUTION

All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone upon completion of work.

##### 3.26.5.1 BALANCED TWISTED PAIR CABLE TESTING

- Field-test instruments shall have the latest software and firmware installed.
- Permanent Link test results including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- Testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.

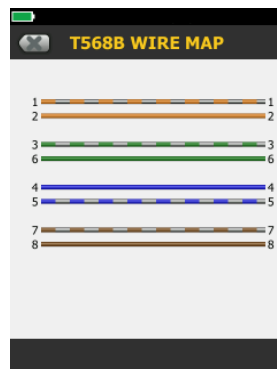
- Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 and 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 5e or Category 6 Permanent Link test, dependent on the cabling installed, each day to ensure no degradation of the tester or its permanent Link adapters.

#### 3.26.5.2 WIRE MAP MEASUREMENTS

The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:

- Continuity to the remote end
- Shorts between any two or more conductors
- Reversed pairs
- Split pairs
- Transposed pairs
- Distance to open on shield
- Any other miss-wiring

The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. T568B color scheme is permitted.



#### 3.26.5.3 LENGTH MEASUREMENT

The length of each balanced twisted pair shall be recorded.

Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.

The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.

#### 3.26.6 ADMINISTRATION

##### Test Results Documentation

- Test Results saved within the field-test instrument shall be transferred into a Windows® based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
- The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner and Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
- The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on an external thumb drive prior to Owner and Owner's representative acceptance of the building. This external thumb drive shall include the software tools required to view, inspect, and print any selection of the test reports.

## 3.27 TESTING, IDENTIFICATION and ADMINISTRATION OF FIBER INFRASTRUCTURE

### 3.27.1 SCOPE

This section includes the minimum requirements for the test certification, identification, and administration of backbone optical fiber cabling.

- Fiber optic test instruments
- Fiber optic testing
- Identification
  - Labels and labeling
- Administration
  - Test results documentation
  - As-built drawings

Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end faces shall also be verified.

Testing shall be performed on each cabling link. (connector to connector)

All tests shall be documented including OLTS dual wavelength attenuation measurements and OTDR traces with event tables as well as OTDR maps.

### 3.27.2 QUALITY ASSURANCE

All testing procedures and field-test instruments shall comply with applicable requirements of:

- ANSI Z136.2, ANS For Safer Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
- ANSI/EIA/TIA-455-50B, Light Launch Conditions for Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
- ANSI/EIA/TIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR
- ANSI/EIA/TIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR
- ANSI/EIA/TIA-455-61A, Measurement of Fiber or Cable Attenuation Using and OTDR
- ANSI/EIA/TIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant
- ANSI/TIA-526-14-B, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
- TIA-TSB-4979 Practical Considerations for Implementation of Multimode Launch Conditions in the Field
- ANSI-TIA-568-D.0, Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568-D.1, Commercial Building Telecommunications Cabling Standard
- ANSI/TIA-568-D.3, Optical Fiber Cabling Components Standard
- ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including requirements specified by the customer, unless the customer specifies their own labeling requirements.

Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

- Manufacturer of the fiber optic cable and/or the fiber optic connectors
- Manufacturer of the test equipment used for the field certification.
- Training organization (e.g., BICSI, Association of Cabling Professionals [ACP])

### 3.27.3 ACCEPTANCE OF TEST RESULTS

Unless otherwise specified by the Owner and/or Owner's representative, each cabling link shall be in compliance with the following test limits:

#### 3.27.3.1 OPTICAL LOSS TESTING

- Multimode or Singlemode links
  - The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568-D.0
    - $\text{Link Attenuation (dB)} = \text{Cable\_Attn (dB)} + \text{Connector\_Attn (dB)} + \text{Splice\_Attn (dB)}$
    - $\text{Cable\_Attn (dB)} = \text{Attenuation\_Coefficient (dB/km)} * \text{Length (Km)}$
    - $\text{Connector\_Attn (dB)} = \text{number\_of\_connector\_pairs} * \text{connector\_loss (dB)}$
    - Maximum allowable connector\_loss = 0.75 dB
    - $\text{Splice\_Attn (dB)} = \text{number\_of\_splices} * \text{splice\_loss (dB)}$

- Maximum allowable splice\_loss = 0.3 dB
- The values for the Attenuation\_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

### 3.27.3.2 OTDR TESTING

- Reflective events (connections) shall not exceed:
  - 0.75 dB in optical loss when bi-directionally averaged
  - -35 dB Reflectance for multimode connections
  - -40 dB Reflectance for UPC singlemode connections
  - -55 dB Reflectance for APC singlemode connections
- Non-reflective events (splices) shall not exceed 0.3 dB.
- Magnified end face inspection
  - Fiber connections shall be visually inspected to IEC 61300-3-35 Edition for end face quality.
  - Scratched, pitted or dirty connectors shall be diagnosed and corrected.

All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation provided to the Owner or Owner's representative prior to final acceptance.

### PERFORMANCE SPECIFICATION FOR MULTIMODE FIBER LINKS AT 850 nm

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		FibreChannel 1200-MX-SN-I	
	µm	(MHz • Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)
OM1	62.5	200	275	2.38	33	2.5	33	2.4
OM2	50	500	550	3.56	82	2.3	82	2.2
OM3	50	2000	N/A	N/A	300	2.6	300	2.6
OM4	50	47000	N/A	N/A	400	2.9	N/A	N/A

### 3.27.4 PRODUCTS

#### 3.27.4.1 OPTICAL FIBER CABLE TESTERS

The field-test instrument shall be within the calibration period recommended by the manufacturer and a copy of the calibration certificate made available.

#### 3.27.4.2 OPTICAL LOSS TEST SET (OLTS)

##### Multimode optical fiber light source

- Provide dual LED light sources with central wavelengths of 850 nm (±30 nm) and 1300 nm (±20 nm). VCSEL sources are not permitted per ANSI/TIA-526-14-B.
- Output power of -20 dBm minimum
- The launch shall meet the Encircled Flux launch requirements of ANSI/TIA-526-14-B
- The test reference cords must demonstrate an insertion loss ≤ 0.15 dB when mated against each other.
- ACCEPTABLE MANUFACTURERS – Fluke Networks

##### Singlemode optical fiber light source

- Provide dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1550 nm (±20 nm).
- Output power of -10 dBm minimum
- The test reference cords must demonstrate an insertion loss ≤ 0.25 dB when mated against each other.
- ACCEPTABLE MANUFACTURERS – Fluke Networks

#### Power Meter

- Provide 850 nm, 1300 nm, 1310 nm, and 1550 nm wavelength test capability.
- Power measurement uncertainty of  $\pm 25$  dB
- Store reference power measurements
- Save at least 10,000 results to internal memory.
- PC interface (USB)
- ACCEPTABLE MANUFACTURERS – Fluke Networks

#### OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

- Shall have a bright, color LCD display with backlight.
- Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
- Weight with battery and module of not more than 4.5 lb and volume of not more than 200 in<sup>3</sup>
- Internal non-volatile memory with capacity for storing at least 2,000 OTDR bi-directionally tested fiber links.
- USB port to transfer data to a PC or thumb drive/memory stick.

#### Multimode OTDR

- Wavelengths of 850 nm ( $\pm 10$  nm) and 1300 nm ( $\pm 35$  nm / -15 nm)
- Event dead zones not to exceed 0.7 m at 850 nm and 1300 nm.
- Attenuation dead zones not to exceed 2.5 m at 850 nm and 4.5 m at 1300 nm.
- Distance range not less than 9,000 m
- Dynamic range at least 28 dB for 850 nm and 30 dB at 1300 nm
- Allow bi-directional testing without moving the OTDR to the far end.
- ACCEPTABLE MANUFACTURERS – Fluke Networks

#### Singlemode OTDR

- Wavelengths of 1310 nm ( $\pm 25$  nm) and 1550 nm ( $\pm 30$  nm)
- Event dead zones not to exceed 0.6 m at 1310 nm and 1550 nm.
- Attenuation dead zones not to exceed 3.7 m at 1310 nm and 1550 nm.
- Distance range not less than 80 km at 1310 nm and 130 km at 1550 nm
- Dynamic range at least 32 dB for 1310 nm and 30 dB at 1550 nm
- Allow bi-directional testing without moving the OTDR to the far end.
- ACCEPTABLE MANUFACTURERS – Fluke Networks

#### Fiber Microscope

- Field of view 420  $\mu$ m x 320  $\mu$ m
- Video camera system is preferred.
- Camera probe tips that permit inspection through adapters are required.
- Test equipment shall be capable of saving and reporting the end face image to IED 613003-3-35
- ACCEPTABLE MANUFACTURERS – Fluke Networks

#### Integrated OLTS, OTDR and Fiber Microscope

- Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.
- ACCEPTABLE MANUFACTURERS – Fluke Networks

#### 3.27.5 EXECUTION

All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

All outlets, cables patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone upon completion of work.

##### 3.27.5.1 OPTICAL FIBER CABLE TESTING

- Field-test instruments shall have the latest software and firmware installed.
- Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- Testing shall be performed on each cabling segment (connector to connector)
- Testing of the cabling shall be performed using high-quality test reference cords of the same core size as the cabling under test, terminated with reference grade connectors. Reference grade connectors are defined as having a loss

not exceeding 0.1 dB for multimode and 0.2 dB for singlemode. The test reference cords for OLTS testing shall be between 2 m and 5 m in length. The length of the launch and tail fibers for multimode OTDR testing shall be at least 100 m (328 ft.). For singlemode, the length of the launch and tail fibers will depend on the link under test. As a guide, the following table can be used for determining the length of the launch and tail fibers.

Maximum Length of Link (km)		Typical Pulse Width (ns)	Minimum Launch and Tail Cord Length (m)
1310 nm	1550 nm only		
0 to 35	0 to 50	≤ 1,000	130
35 to 45	50 to 65	3,000	400
45 to 50	65 to 75	10,000	1,000
≥ 50	≥ 75	20,000	2400

### 3.27.5.2 OPTICAL LOSS TESTING

#### Backbone Links

- Multimode links shall be tested in one direction at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14-B, one-cord reference method, with an Encircled Flux compliant launch.
- Singlemode backbone links shall be tested in one direction at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1 (One-cord reference method)
- Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e., link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

### 3.27.5.3 OTDR TESTING

Fiber links shall be tested at these wavelengths for anomalies and to ensure uniformity of cable attenuation, connector insertion loss and reflectance.

- Multimode: 850 nm and 1300 nm
- Singlemode: 1310 nm and 1550 nm

Each fiber link and channel shall be tested in both directions.

- The launch and tail fibers shall remain in place for the measurement in the opposite direction – failing to do so will result in an increase in measurement uncertainty.
- The use of loop back fiber at the far end with a tail fiber at the near end on the adjacent fiber is permitted for bi-directional testing, so long as the OTDR is able to split the trace automatically into two traces for the two fibers under test.

A launch cable shall be installed between the OTDR and the first link connection.

A tail cable shall be installed after the last link connection.

### 3.27.5.4 LENGTH MEASUREMENT

The length of each cable shall be recorded.

It is preferable that the optical length be measured using an OLTS or OTDR.

### 3.27.5.5 POLARITY TESTING

Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA-568-D.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

### 3.27.6 ADMINISTRATION

#### Test Result Documentation

- Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. The following formats do not provide adequate protection of these records and shall not be used.
  - Portable Document Format (PDF)
  - Word (.doc & .docx)
  - Comma Separated Values (.csv)
  - Excel separated values (.xls & .xlsx)

- Text (.txt)
- The test results documentation shall be available for inspection by the Owner and the Owner's representative during the installation period and shall be passed to the Owner and Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
- The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on an external thumb drive prior to the Owner acceptance of the building. This external thumb drive shall include the software tools required to view, inspect, and print any selection of the test reports.

### 3.28 LABELING AND ADMINISTRATION

Comply with ANSI/TIA/EIA-606 standard for all telecommunications structured cabling system work. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels, and outlets. All label printing shall be machine generated using a computer, Brady, or Panduit handheld label maker. Self-laminating labels shall be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet identification shall be labeled on the space provided on the faceplate. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

#### 3.28.1 Cable System Identification

All labels shall be machine-printed, crisp, clear, non-smearing and extremely legible. Labels shall be durable for the life of the system (the 15+ year system warranty). Labels which can be easily removed shall not be utilized.

Racks, cabinets, enclosures, and connection hardware shall be labeled to identify the location within the cabling system infrastructure.

All connection hardware including but not limited to patch panels and work area outlet faceplates shall be labeled.

- All labeling shall meet the following:
  - All labels or means of identification shall utilize machine-printed type to be utilized for ISP cable labels, OSP (horizontal) cables, racks, and grounding busbars.
  - Size according to cable diameter and readability.
  - Shall be thermal-transfer type and utilize self-adhesive labels.
  - Labeling shall also be provided for all Manholes, Hand holes, transition boxes, and boxes containing other LV systems such as Access control, paging, and intercom.
  - All indoor transition boxes that contain fiber optic cabling shall be labeled with a proper Fiber optic cable warning sticker on the outside cover.
  - Panduit PST-FO self-laminating label for fiber optic cable labeling
- FACEPLATES AND PATCH PANELS LABELS
  - Faceplates shall have integral slots for label inserts.
  - Have cable identifications machine-printed onto label inserts and populate the integral slots with these inserts.
  - Patch Panels shall be labeled per Kroger Labeling standards.
  - DO NOT label ports on the patch panel. Patch panel ports will identify the horizontal cable port assignment.
- GROUNDING AND BONDING CONDUCTORS
  - Warning Marker
    - Non-metallic, machined and pre-printed as a wrap-around marker (not a flag marker).
  - Identification Label
    - Label shall be self-laminating, machine- and thermal-printed.
    - Size of label will vary with size of conductor:
      - For 18-14AWG, 1.00"x0.75" label
      - For 12-10AWG, 1.00"x1.25" label
      - For 8-4AWG, 1.00"x2.25" label
      - For 2-1AWG, 1.00"x4.00" label
      - For 1/0-250kcmil, 1.00"x6.50" label

#### 3.28.2 Labeling Scheme

##### Work Area Faceplate

The type and color of the icons for each outlet on the work area outlet faceplate must directly correspond with the icon on the patch panels. Every horizontal UTP cable present at each faceplate must have its own unique identifier (label). Labels shall be black lettering on a white background. Handwritten labels are not acceptable.

Each faceplate location shall be labeled with the following information for each horizontal UTP cable:

B = identifies the building on campus (alpha character), if applicable  
F = identifies the floor in the building of the telecom space (numeric character), of multiple floors  
S = identifies the telecommunications space (alpha character)  
Y = identifies the rack number within the telecommunications space (numeric character)  
A = identifies the patch panel location starting from the top of the rack/cabinet (alpha character)  
P = identifies the port on the patch panel (numeric character)

For example, the 5th port on patch panel A in Rack 2 originating from TR B on the 2<sup>nd</sup> floor in Building B would be labeled, B2BA05.

#### Patch Panels

Each patch panel shall be labeled its alpha character in two locations: left side centered and right-side centered, starting with the top patch panel in sequential alpha character order. Labels shall be black lettering on a white background. Handwritten labels are not acceptable.

#### Horizontal Cables

All horizontal cables must be labeled with their own unique identifier. Labels shall be black lettering on white background containing the cable identifier. The labels shall be placed on the cable 4-inches from the point of termination and in the same direction for all cables. Handwritten labels are not acceptable.

Each horizontal cable label shall follow the same labeling scheme as the work area outlet faceplate labeling scheme.

#### Racks/Cabinets

All racks/cabinets shall be labeled at the top and bottom. Labels shall be black lettering on yellow background 24 point font.

Each rack/cabinet shall be labeled with the following information:

ER/TR = identifies the telecommunications space type  
B = identifies the building on campus (alpha character), if applicable  
F = identifies the floor in the building of the telecom space (numeric character), if multiple floors  
S = identifies the telecommunications space (alpha character)  
R = identifies the rack/cabinet within the telecommunications space (numeric character)

For example, Rack 2 in telecommunications space TR-C on the 3<sup>rd</sup> floor in Building A would be labeled, TR-A3C-02

#### Fiber Optic & Copper Multi-Pair Backbone Cables

All fiber optic and copper multi-pair backbone cables must be labeled with their own unique identifier. Labels shall be black lettering on white background containing the cable identifier. The labels shall be placed on the cable jacket 4-inches from the point of jacket removal and in the same direction for all cables. Handwritten labels are not acceptable.

Each fiber optic and copper multi-pair backbone cable shall be labeled with the following information:

S1 = identifies the telecommunications space containing the termination (alpha character)  
S2 = identifies the remote telecommunications space containing the other end of the terminations (alpha character)  
N = identifies the total copper backbone pair count OR fiber optic backbone strand count

Continued for Copper Multi-Pair Backbone Cables

C = identifies the cable count; either the cable number "01" (DMARC Extension) or "SPLIT" (DMARC Extension) or "C" (Telecom Space alpha character)

Continued for Fiber Optic Backbone Cables

MM = identifies the fiber optic cable as multimode  
SM = identifies the fiber optic cable as single mode  
R = identifies fiber optic backbone redundancy, primary (P) or secondary (S) route



#### Fiber Optic & Copper Multi-Pair Backbone Patch Panel

Each backbone patch panel will be labeled on two locations – left side middle and right-side, middle, starting with the top patch panel in sequential alpha character order. Labels shall be black lettering on a white background. Handwritten labels are not acceptable.

Fiber Optic and Copper Multi-Pair Backbone patch panels shall be labeled to identify the remote end termination location (i.e. TE-C). Labels shall be black lettering on a white background. Handwritten labels are not acceptable.

#### Telecommunications Grounding & Bonding

Label TMGB as FLOOR# - ROOM# - TMGB.

Label TGBs as FLOOR# - ROOM# - TGB.

Label grounding conductors within 12" of both ends with Warning Marker and Identification Label.

Identification label is to include the source and destination of the grounding conductor.

## DOCUMENT HISTORY

Version	Summary of Changes	Issue Date
V1	Initial release	June 2016
V1.1	Section 4.5.2 Recommended Kroger Installation Practices: Installation guidelines and General Connectivity Drawings have been updated to match current Bogen design requirements	September 2016
V1.2	Revised Section 4 – APPENDIX A – Bogen Paging Systems with Bogen’s latest release of Recommended Kroger Installation Practices for GS “D” Amplifiers, <i>Revision 4.3 Completed 3 January 2017</i> Updated document expiration date to December 31, 2017	January 2017
V2.1906	Updated document expiration date	June 2019
V3.2401	Revised document to align with and supplement the Scope of Work document	January 2024