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ACRONYMS

<b>AA</b>	Assa Abloy (Door Hardware)
<b>BKF</b>	BKF Engineers (Civil)
<b>CEC</b>	Capital Engineering Consultants, Inc. (Mech & Plumb)
<b>CMS</b>	Charles M. Salter Associates (Acoustics, AV, Telecom & Security)
<b>EFI</b>	Environmental Foresight Inc. (Landscape)
<b>GBS</b>	Gary Barnett Specifications
<b>KPFF</b>	KPFF Consulting Engineers (Structural)
<b>WHM</b>	WHM Inc. (Electrical)

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**BID PROPOSAL**

**Project:      **BID #06-1617**  
                  **PLANETARIUM**  
                  **West Valley College****

Bidder Name	_____	
Bidder Representative(s)	Name and Title _____	
	Name and Title _____	
Bidder Representative(s) Contact Information	Email Address(es) _____	Phone/Fax _____
	_____	(_____) Telephone _____ (_____) Fax _____
Bidder Mailing Address	Address _____	
	City/State/Zip Code _____	
California Contractors' License	Number _____	
	Classification(s) and Expiration Date _____	

1. Bid Proposal.

1.1. Bid Price. The undersigned Bidder proposes and agrees to perform the Work including, without limitation, providing and furnishing all labor, materials, tools, equipment and services necessary to complete the Work and perform all obligations of the Contractor under the Contract Documents, in accordance with the terms of the Contract Documents for the sum of \_\_\_\_\_ Dollars (\$ \_\_\_\_\_) ("Bid Price").

1.2. Allowances. The Bid Price set forth in Paragraph 1.1 above is inclusive of all of the following Allowance Items, if any, noted below and the Bid Price incorporates the Allowance Amount allocated for each Allowance Item, as set forth below. If the cost to furnish and install an Allowance Item is less than the Allowance Amount allocated below for an Allowance Item, the District will issue a unilateral deductive Change Order for the unused portion of the Allowance Amount allocated for an Allowance Item. If the cost to furnish and install an Allowance Item exceeds the Allowance Amount allocated for the Allowance Item, a Change Order will be issued in accordance with the Changes provisions of the Contract Documents for costs exceeding the Allowance Amount.

Allowance Item No.	Allowance Item Description	Allowance Amount
A-1	Site Soil Stabilization & Lime Treatment	\$100,000

Allowance Item No.	Allowance Item Description	Allowance Amount
A-2		\$ _____
A-3		\$ _____
Aggregate Allowance Amount		\$ 100,000

1.3. Breakdown of Bid Price. The Bid Price is broken down between the price proposed for the base scope of Work and Allowances as follows:

A	Base Bid Price	\$ _____
B	Allowances	\$100,000
<b>Bid Price</b> <i>Base Bid Price plus Allowances (A+B)</i>		\$ _____

1.4. Acknowledgment of Bid Addenda. The Bidder confirms that: (i) this Bid Proposal incorporates and is inclusive of, all items or other matters contained in Bid Addenda, if any, issued by or on behalf of the District; and (ii) the Bid Price incorporate pricing effects of Bid Addenda, if any.

\_\_\_\_\_ Addenda Nos. \_\_\_\_\_ received, acknowledged  
(initial) and incorporated into this Bid Proposal.

1.5. Alternate Bid Items. The Bidder’s proposed pricing for each Alternate Bid Item, if any, are set forth in the accompanying form of Alternate Bid Items Proposal. Failure of a Bidder to propose pricing for each Alternate Bid Item set forth in the accompanying Alternate Bid Items Proposal will result in the Bid Proposal being deemed non-responsive and rejected.

2. Documents Accompanying Bid Proposal. The Bidder has submitted with this Bid Proposal the following:

Bid Security	Statement of Bidder’s Qualifications
Subcontractors List	Copy of Bidder’s Injury and Illness Prevention Program (“IIPP”)
Non-Collusion Affidavit	DIR Registration Verification

The Bidder acknowledges that if this Bid Proposal and the foregoing documents are not fully in compliance with applicable requirements set forth in the Call for Bids, the Instructions for Bidders and in each of the foregoing documents, the Bid Proposal may be rejected as non-responsive.

3. Unit Prices: Unit Prices shall be used, where applicable, to make adjustments to the cost of the Work due to changes. All Unit Prices submitted shall be complete in-place prices (unless noted otherwise) and include all costs for overhead and profit in accordance with the Contract Documents, labor, materials, equipment, and any other incidentals related to the completion of the Work, and shall remain firm for the period of the contract. Unit Prices listed are for additive work. Deductive unit prices in all cases are to be calculated the same as additive unit prices (100% if used in conjunction with an allowance).



Item Description	Unit Price
<p><u>Repair Mortar:</u> Furnish Unit Price as dollars per square foot as per 09 05 16-1.2A, Preparation of Concrete Slabs for Finish Flooring, for specified repair mortar to concrete slab areas that do not meet the floor covering manufacturer's substrate requirements.</p>	<p>\$ _____</p>
<p><u>Vapor Emission Control System:</u> Furnish Unit Price as dollars per square foot as per 09 05 16-1.2A, Preparation of Concrete Slabs for Finish Flooring, for specified vapor emission control systems (VECS) as a topical remediation for concrete slabs that do not meet the adhesive and floor covering manufacturers' RH, MVER, or pH requirements.</p>	<p>\$ _____</p>

4. Award of Contract. If the Bidder submitting this Bid Proposal is awarded the Contract, the undersigned will execute and deliver to the District the Agreement in the form attached hereto within Seven (7) calendar days after notification of award of the Contract. Concurrently with delivery of the executed Agreement to the District, the Bidder awarded the Contract shall deliver to the District: (i) OCIP Enrollment Forms for the Bidders and its Subcontractors; (ii) Certificates of Insurance evidencing all insurance coverages the Bidder and its Subcontractors are required to obtain under the Contract Documents; (iii) Performance Bond; (iv) Labor and Material Payment Bond; (v) Certificate of Workers' Compensation Insurance; and (vi) Drug-Free Workplace Certificate. Failure of the Bidder awarded the Contract to strictly comply with the preceding may result in the District's rescinding award of the Contract and/or forfeiture of the Bidder's Bid Security. In such event, the District may, in its sole and exclusive discretion elect to award the Contract to the responsible Bidder submitting the next lowest priced Bid Proposal or to reject all Bid Proposals.
  
5. Contractors' License. The Bidder certifies that: (i) it is possesses a valid and in good standing Contractors' License, in the necessary class(es), for performing the Work as set for in the Call for Bids; (ii) that such license shall be in full force and effect throughout the duration of the performance of the Work; and (iii) that all Subcontractors providing or performing any portion of the Work are properly licensed to perform their respective portions of the Work at the time of submitting this Bid Proposal and will remain so properly licensed at all times during their performance of the Work.
  
6. Agreement to Bidding Requirements and Attorneys Fees. The undersigned Bidder acknowledges and confirms its receipt, review and agreement with, the contractual requirements set forth in this Bid Proposal and the Contract Documents. By executing this Bid Proposal hereinbelow, the Bidder expressly acknowledges and agrees that if the Bidder institutes any legal or equitable proceedings in connection with this Bid Proposal and the District is named as a party thereto, the prevailing party(ies) shall recover from the other party(ies), as costs, all attorneys' fees and costs incurred in connection with any such proceeding, including any appeal arising therefrom. This provision shall constitute a binding attorneys' fee agreement in accordance with and pursuant to California Civil Code §1717 which shall be enforceable against the Bidder and the District. This attorneys' fee provision shall be solely limited to legal or equitable proceedings arising out of a bid protest or the bidding process and shall not extend to or have any force and effect on the Contract for the Work or to modify the terms of the Contract Documents for the Work.

7. Acknowledgment and Confirmation. The undersigned Bidder acknowledges its receipt, review and understanding of the Drawings, the Specifications and other Contract Documents pertaining to the proposed Work. The undersigned Bidder certifies that the Contract Documents are, in its opinion, adequate, feasible and complete for providing, performing and constructing the Work in a sound and suitable manner for the use specified and intended by the Contract Documents. The undersigned Bidder certifies that it has, or has available, all necessary equipment, personnel, materials, facilities and technical and financial ability to complete the Work for the amount bid herein within the Contract Time and in accordance with the Contract Documents.

By: \_\_\_\_\_  
(Signature of Bidder's Authorized Officer  
or Representative)

\_\_\_\_\_  
(Typed or Printed Name)

Title: \_\_\_\_\_

**ALTERNATE BID ITEMS PROPOSAL**

**Project:** **BID #06-1617**  
 **PLANETARIUM**  
 **West Valley College**

**Bidder Name:** \_\_\_\_\_

Bidders must provide a proposal price for each Alternate Bid Item set forth herein; failure to do so will result in rejection of the Bid Proposal for non-responsiveness. The amount proposed for each Alternate Bid Item by the above-identified Bidder is set forth hereinbelow:

**Alternate Bid Item No. 1.:** Ulteria Seam for Dome Projection Screen

Check the following and indicate the additive proposed price for the foregoing Alternate Bid Item.

Add \_\_\_\_\_ Dollars (\$\_\_\_\_\_) to the Bid Price set forth in Paragraph 1.3 of the Bid Proposal.

**Alternate Bid Item No. 2.:** Roof Observatory Enclosure

Check the following and indicate the additive proposed price for the foregoing Alternate Bid Item.

Add \_\_\_\_\_ Dollars (\$\_\_\_\_\_) to the Bid Price set forth in Paragraph 1.3 of the Bid Proposal.

**Alternate Bid Item No. 3.:** Roof Antenna

Check the following and indicate the additive proposed price for the foregoing Alternate Bid Item.

Add \_\_\_\_\_ Dollars (\$\_\_\_\_\_) to the Bid Price set forth in Paragraph 1.3 of the Bid Proposal.

Dated \_\_\_\_\_

By: \_\_\_\_\_  
(Signature of Bidder's Authorized Officer or Representative)

\_\_\_\_\_  
(Typed or Printed Name)

Title: \_\_\_\_\_



## SECTION 01 11 00 SUMMARY OF WORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes:
  - 1. Work covered by the Contract Documents.
  - 2. Type of Contract.
  - 3. Work phases.
  - 4. Work under other contracts.
  - 5. Products ordered in advance.
  - 6. Owner-furnished products.
  - 7. Use of premises.
  - 8. Owner's occupancy requirements.
  - 9. Work restrictions.
- B. Related Sections include:
  - 1. Section 01 27 50 "Allowances" for descriptions and procedures on the use of allowances. (IF APPLICABLE)
  - 2. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

#### 1.3 PROJECT INFORMATION

- A. Project Identification      Kvamme Planetarium Addition  
14000 Fruitvale Avenue  
Saratoga, CA 95070
- B. Owner:                              West Valley-Mission Community College District  
14000 Fruitvale Avenue  
Saratoga, CA 95070
- C. Architect:                              tBP/Architecture  
1777 Oakland Boulevard, Suite 320  
Walnut Creek, CA 94596
- D. Construction Manager:      Deedee Flauding  
Gilbane Building Company  
1798 Technology Drive, Suite 120  
San Jose, CA 95110  
dflauding@gilbaneco.com

The Construction Manager has been engaged for this project to serve as an advisor to Owner and to provide assistance in administering the Contract for Construction between Owner and Contractor, according to a separate contract between Owner and Construction Manager.

#### 1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work consists and includes but is not limited to:  
Furnish all labor, materials, equipment and services as required to satisfactorily complete all Work required for the construction and completion of the Kvamme Planetarium Addition as defined below and in accordance with the Drawings and Specifications provided for This Contract.

##### 1. Specific Work Scope

- a. Construction of Planetarium building, including installation of Owner-furnished planetarium dome.
- b. Infrastructure and equipment as noted for audio-visual, telecommunications, and security.
- c. Landscape, hardscape, and seat walls adjacent to the building.

##### 2. Alternates:

a. Additive Alternate #1: Provide a cost for the "Ulteria Seam" seaming process for the Planetarium Dome projection screen. Refer to Specification 11 52 13.

b. Additive Alternate #2: Roof Observatory Enclosure – Provide a cost for an 18' Enclosure (200" base diameter) by **Astro Haven Enterprises** along with the assembly and complete installation of the enclosure on the Planetarium building roof. The cost should identify the following components:

Qty. (1): D01800-032: 18 ft. Dome VI-IH E-RelayBG:230V 1Ph Bd/ABB  
1.0/1.0/2.0 Door-Slam

Qty. (1): S 18ft Crating (Crating and Handling 18ft)

Qty. (1): AA00068-001: Convenience, Mounting Rail Lights & Accessories 18ft

Qty. (2): AA00085-004 GMC (Gear Box Manual Crank) Full Kit (1) 16-18ft

Qty. (1): Manufacturer Install Support

Qty. (1): Split-system AC unit (keynotes 18, 19, and 20 on A-3.0)

Required power for all components above."

c. Additive Alternate #3: Roof Antenna – Provide a cost for a 3-meter dish antenna along with the assembly and complete installation of the Planetarium building roof. The cost should identify the following components or their equivalent:  
RF HAMDESIGN B.V., Drachten, Netherlands.

Qty. (1): FPD 3M0 KIT: Mesh dish 3 meter diameter, available F/D=0.4/0.45  
(2.8mm sq mesh / max 11GHz)

Qty. (1): SPID RAS/HR: SPID AZ & EL (hor. + vert.) antenna rotor, incl.  
controller, type MD-02, build in interface, software

Qty. (1): FPD-BR02: SPID RAS rotator mounting bracket Rotator <> DISH

Qty. (1): PW32015: Power Supply Unit 18 Volt / 20 Amp, For use with SPID RAS  
& BIG-RAS rotators

-

Qty. (1) SPID-ADAPT: SPID Adaption plate for use to mount rotor on base plate in tower.

Qty: (50 meters): CC8-001/25: Control cable 8-core 8x1,5sq.mm, 25 meter, (max reel 50 meter) for Dual-Ax SPID Rotators

Qty (1) 4" OD Mast Pipe Galvanized Steel 8 foot length

3. Milestone Dates

Board Approval of Contract Award November 15, 2016

Notice to Proceed (Estimated) (DATE TBD) November 22, 2016

1.5 TYPE OF CONTRACT

A. Project will be constructed under a single-prime contract arrangement.

1.6 WORK UNDER OTHER CONTRACTS

A. General: Cooperate fully with Owner's separate contractors so work on those contracts may be carried out smoothly, without interfering or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1. Various other Projects on the West Valley College Campus

1.7 OWNER-FURNISHED PRODUCTS

A. Planetarium Dome by Astro-Tec Manufacturing, Inc

1.8 USE OF PREMISES

A. General: Contractor shall have limited use of premises for construction operations as directed by the Owner and as shown on the drawings.

B. Use of Site: Limit use of premises to areas within Contract limits. Do not disturb portions of Project site beyond areas in which the "Allowed Work Areas" are indicated.

C. Provide for emergency vehicles at all times.

D. This Contractor shall utilize chain link fencing, traffic control and signage around all site work during construction at ALL TIMES for the safety of WVC staff and students. Contractor shall assume that Campus access roads must remain open and operating at all times during This Contractor's Work activities.

E. Limits: Allow for Owner occupancy of Project site.

1. Access Roads, Driveways, Entrances, and Pedestrian pathways: Keep driveways, parking areas, loading areas, entrances, and pedestrian pathways serving premises as clear as construction operations will allow. Remove temporary fencing and clean work areas as soon as work areas are completed.

2. Temporary storage of materials will be allowed on a case-by-case basis. Contractor will be allocated a designated area on Campus for site utilization, storage, and parking.

a. Schedule deliveries to minimize use of driveways and entrances.

- b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- F. Do not unreasonably encumber site with materials or equipment. Confine stockpiling of materials and location of storage areas to areas as directed by Owner.
- G. Smoking or open fires are prohibited on campus.

#### 1.9 OWNER'S OCCUPANCY REQUIREMENTS

- A. Partial Owner Occupancy: Owner will occupy the campus during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform Work so as not to interfere with Owner's operations. Maintain existing exits, vehicular routes, and pedestrian paths, unless otherwise indicated.
  - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
  - 2. Provide not less than five working days notice to Owner of activities that will affect Owner's operations. Coordinate with Construction Manager for advance notice of construction and impediments to the Campus operations.
- B. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and use the completed areas of site, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
  - 1. Engineer will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.
  - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
  - 3. Before partial Owner occupancy, utility, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of the campus.
  - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of the campus.

#### 1.10 WORK RESTRICTIONS

- A. On-Site Work Hours: The construction hours / days of Work at the Site are 7:30 am to 6:00 pm Monday through Friday. Saturday construction hours are 9:00 am to 5:00 pm and special circumstances Saturday work must be pre-approved by the District in writing coordinated with and by the Construction Manager. Work is prohibited on Sundays and weekday holidays.
- B. Owner's academic calendar is available on-line and reflects the critical dates for campus activities such as the start of each session and the final exam dates. Contractor shall note that at the start of each session, the number of students and vehicles are at the peak.



- C. During the academic school year, the Owner has programs other than the academic session. Some of these programs include, but are not limited to: The Farmers Market; Dance Recitals, Theater Programs, Sports Camps, and Sports Programs.
- D. Contractor shall cooperate and coordinate with Construction Manager to minimize the impact of construction on the campus with school and other program activities.
- E. Do not perform the following types of work until written agreement as to allowable times has been obtained from Owner:
  - 1. Work involving utility shutdowns.
  - 2. Core drilling or other noisy activity.
- F. Construction Notifications shall be given as follows. Contractor shall not proceed with the work or with shutdowns or interruptions until authorized by the Construction Manager in writing:
  - 1. This Work is anticipated to involve daily operations in and around Campus access roadways and pedestrian pathways. Contractor shall be required to update Construction Manager no less than each (3) days for areas of work so that proper Construction Notices may be posted for District and Campus staff and students in advance of construction activities.
  - 2. For electrical power shutdowns anticipated to be less than 1 hour, provide written notice to the Construction Manager a minimum of three (3) work days in advance.
  - 3. For electrical power shutdowns anticipated to be in excess of 1 hour, provide written notice to the Construction Manager a minimum of fourteen (14) work days in advance.
  - 4. For domestic water and gas shut-offs, provide written notice to the Construction Manager a minimum of three (3) work days in advance.
  - 5. For interruptions of low voltage systems such as fire alarm, communication, clock, signal, data and energy management systems, provide written notice to the Construction Manager a minimum of three (3) work days in advance.
  - 6. For high impact activities including but not limited to crane operations, concrete pours, large special deliveries; traffic and road impacts, provide written notice to the Construction Manager a minimum of three (3) work days in advance.

**PRODUCTS (Not Used)**

**PART 2 - EXECUTION**

**2.1 SCHEDULE OF OWNER-FURNISHED PRODUCTS**

- 1. Planetarium Dome by Astro-Tec Manufacturing, Inc.

END OF SECTION 01 11 00



# SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Work Included:
  - 1. Scope of systems and equipment to be commissioned.
  - 2. Commissioning duties and procedures at the site.

### 1.2 RELATED SECTIONS

- A. Division 01, General Requirements applies to this Section.
- B. Contents of Division 23, HVAC and Division 26, Electrical apply to this Section.
- C. In addition, reference the following:
  - 1. 23 08 00, Commissioning of HVAC
  - 2. 26 08 00, Commissioning of Electrical

### 1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by:
  - 1. Division 01, General Requirements.
  - 2. 23 08 00, Commissioning of HVAC
  - 3. 26 08 00, Commissioning of Electrical
- B. Current edition of the ASHRAE Guideline 0, The Commissioning Process.

### 1.4 SUBMITTALS

- A. Submittals as required by:
  - 1. Division 01, General Requirements.
  - 2. 23 08 00, Commissioning of HVAC
  - 3. 26 08 00, Commissioning of Electrical

### 1.5 DEFINITIONS

- A. Commissioning Authority: The Commissioning Authority is the person or entity referred to throughout the Contract Documents as if singular in number who works with the Owner's Representative under a separate Contract.
- B. Commissioning:
  - 1. Commissioning is a process for achieving, verifying, and documenting that performance of a building and its various energy consuming systems meets the Design Engineer's design intent and the Owner's operational needs.
  - 2. Commissioning includes tests for the operation of equipment and building systems to ensure that they operate as designed by the Design Engineer, and meet the needs of the building throughout the entire range of operating conditions.

3. Commissioning is a cooperative effort that requires participation by the Owner's Representative, General Contractor, system and equipment installers, building automation system installer, Testing and Balancing Agency, equipment manufacturers' representatives, Architect, Architect's design engineers, and Commissioning Authority.
- C. Owner's Project Requirements (OPR): Document that details the functional requirements and expectations of how the building will be used and operated. This may include project location, goals, cost considerations, equipment manufacturers, and environmental control requirements.
  - D. Basis of Design (BOD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines.
  - E. Commissioning Procedures:
    1. Inspection and testing procedures that are written by the Commissioning Authority for equipment and systems within the scope of commissioning.
    2. Inspection checklists typically address items of installation compliance with design intent and approved submittals.
    3. Functional performance test procedures typically address all sequences for normal and emergency equipment and system operation. These procedures consist of a mix of One-Time Tests and Continuous Measurement.
    4. One-Time Tests: Functional performance tests of equipment and systems that are performed by forcing specific conditions that are intended to trigger specific responses, per the design intent.
  - F. Continuous Measurements:
    1. Functional performance tests of equipment and systems that are performed by observing parameters of normal operation over an extended period. This is typically accomplished by means of the BAS trend logging capabilities, by monitoring with stand-alone data logging equipment, or by some combination of both.
    2. Temperature conditions in occupied spaces, control stability, and lighting levels in areas with daylighting controls are three typical subjects of continuous measurement.
  - G. Commissioning Plan: The document, provided by the Commissioning Authority, that states the required tests for all equipment and systems within the scope of commissioning.
  - H. Commissioning Meetings: Issues related to commissioning will be discussed as required during regularly scheduled progress meetings.

## 1.6 PERFORMANCE REQUIREMENTS

- A. Testing, inspecting and performance monitoring tasks specified in this Section and in Section 23 08 00, Commissioning of HVAC and Section 26 08 00, Commissioning of Electrical, are the responsibility of the Commissioning Authority, unless specifically indicated otherwise, and not part of the General Construction Contract. These tasks are included in these Sections for the Contractor's information, so the Contractor can understand the standards of system performance that are required and more effectively coordinate with the process of commissioning.
- B. The Commissioning Authority will verify for the Owner's Representative that commissioned mechanical, plumbing, electrical, and controls system function interactively and in compliance with the Project design intent, and to facilitate orderly and efficient transfer of building operating systems to the Owner.
- C. Commissioning does not relieve the Contractor of Contract obligations.

#### 1.7 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

- A. Systems:
  - 1. HVAC Equipment
  - 2. HVAC Controls
  - 3. Lighting Controls (LCP, Daylighting, Occupancy Sensors)

#### 1.8 COMMISSIONING DUTIES

- A. Duties of Owner: Provide the OPR to the Architect/Engineer and Commissioning Authority prior to design development.
- B. Duties of Architect:
  - 1. Attend commissioning portion of Progress Meetings as necessary.
  - 2. Lead the design team in assisting the resolution of deficiencies.
- C. Duties of Architect's Mechanical Engineer:
  - 1. Attend commissioning portion of Project Meetings as necessary.
  - 2. At the request of either the Owner's Representative or the Commissioning Authority, review Commissioning Procedures and submit comments to Owner's Representative.
  - 3. Develop and provide the Basis of Design to Owner and Commissioning Authority prior to 50 percent CD.
  - 4. Assist in resolution of problems and deficiencies that are discovered during commissioning.
  - 5. Perform all construction checklists and provide copies of completed signed construction checklists.
- D. Duties of Architect's Electrical Engineer:
  - 1. Attend commissioning portion of Project Meetings as necessary.
  - 2. At request of either the Owner's Representative or the Commissioning Authority, review Commissioning Procedures and submit comments to Owner's Representative.
  - 3. Develop and provide the Basis of Design to Owner and Commissioning Authority prior to 50 percent CD.

4. Assist in resolution of problems and deficiencies that are discovered during commissioning.
- E. Duties of Commissioning Authority:
1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.
  2. Provide plan to Owner's representative for review and comment.
  3. Prepare commissioning procedures for each commissioned system based on actual system configuration.
  4. Commissioning Procedures written by Commissioning Authority will include, in field data collection format, the detailed test procedures, test conditions, and criteria for acceptance of test results.
  5. Submit any commissioning procedures that are written by Commissioning Authority to the Owner's Representative for review and approval at least one week prior to scheduled field Testing.
  6. Provide personnel experienced in technical aspects of each system to be commissioned for execution of tests.
  7. BAS Sequence Demonstration:
    - a. Witness the Control Contractor's demonstration of their sequence tests.
    - b. If any of the demonstrated sequences fails to operate per the controls submittal, witness the repeat demonstration after corrective action has been taken.
  8. Execute the Commissioning Procedures.
  9. Prepare and submit Observation Reports and Deficiency Reports as required, but within three days of noting any deficiency.
  10. Submit to Owner's Representative a weekly written report of commissioning progress, unresolved deficiencies, and projected inspection, and test schedule during field testing.
  11. Take the lead in timely evaluation of deficiencies, and advise Owner's Representative on resolution.
  12. Assist in resolving commissioned system disputes by performing research to determine the scope of the dispute, and informing the involved parties on possible solutions to disputes.
  13. Verify that the Owner's maintenance personnel are adequately trained as per the Contract Documents and the OPR.
  14. Prepare a Commissioning Report that includes a summary of overall commissioning process, including deficiencies found, deficiency corrections, unresolved deficiencies, approved equipment and systems, discrepancies between final design intent and as-built systems, completed commissioning checklists, test documentation, and other commissioning documentation.
  15. Develop a Systems Manual which describes system descriptions, sequence of operations, general maintenance requirements and intervals, recommended sensor calibration and energy efficiency best practices.
- F. Duties of General Contractor:
1. Attend commissioning portion of Project Meetings as necessary, minimum four meetings.
  2. Participate in resolution of problems and deficiencies that are discovered during commissioning.

3. Coordinate and direct system installers in executing their commissioning tasks.
  4. Coordinate with Commissioning Authority on integration of construction and commissioning schedules.
  5. Oversee and perform documentation requirements for all Pre-Functional Checklists.
  6. Notify Commissioning Authority when all the following has been achieved. It is permissible, with prior approval by Commissioning Authority, to provide notification for individual systems as the following are all completed for each system.
    - a. All controls point-to-point and sequence checkout is complete.
    - b. All test and balancing is complete.
    - c. Normal equipment schedules have been activated
    - d. All control overrides and temporary valves have been returned to normal automatic control.
    - e. All manual isolation valves have been left open.
    - f. Piping and duct systems have been cleaned and tested.
    - g. Heating water system is fully operational under normal automatic operation.
    - h. Luminaires are installed with operational daylighting controls and occupancy sensors.
    - i. Distribution boards, including overcurrent devices, containing breakers over 600 amps, are installed.
    - j. Building inspector acceptance of emergency lighting system following their site inspection.
  7. Provide all startup, flushing, pressure testing, etc results/reports for commissioned systems.
- G. Duties of Installer's and Manufacturer's Representatives:
1. Attend commissioning portion of Project Meetings as necessary.
  2. Participate in resolution of problems and deficiencies that are discovered during commissioning.
  3. Within three months of the award of the Contract, as part of the required submittals for the contract, Contractor submits manufacturer's startup and installation procedures as well as controls point-to-point and sequence checkout and provides in checkset format for each piece of equipment and controls.
  4. Assist Commissioning Authority by completing certain sections of the Commissioning Procedures.
  5. Commissioning does not relieve installers from obligations to complete Work as required by Contract Documents.
- H. Duties of BAS Installer:
1. Attend commissioning portion of project meetings as necessary, minimum two meetings.
  2. Review and approve Commissioning Procedures as relevant to controls work.
  3. Point-to-Point Checkout:

- a. Perform point-to-point checkout and calibration of all energy management system points.
  - b. Checkout and calibration on forms as approved by mechanical designer, and/or Commissioning Authority.
  - c. Submit three copies of the completed point-to-point checkout forms to the Owner's Representative within five working days of completion of field checkout. Distribute copies to the Commissioning Authority and the designer.
4. Control Sequence Testing:
- a. Prepare control sequence test procedure forms of a degree of rigor comparable to the Commissioning Authority's Commissioning Procedures.
  - b. Submit test procedure forms to the Commissioning Authority for approval at least two weeks prior to intended sequence testing. At the contractor's option, it is acceptable to use the Commissioning Authority's Commissioning Procedures, substituting one-time tests for continuous measurement wherever applicable. However, it is still necessary to submit any edited Commissioning Authority Commissioning Procedures as least two weeks prior to intended sequence testing.
  - c. Submit the completed sequence testing forms to the Owner's Representative. The Owner's Representative distributes copies to the Commissioning Authority and the designer.
5. Submit to Commissioning Authority, prior to Sequence Demonstration, two copies of installed control Drawings, sequence narratives, control wiring diagrams and program code or block diagrams.
6. Sequence Demonstration:
- a. After completing and documenting all required sequence tests with own staff, demonstrate sequence tests to the Commissioning Authority. Demonstration is to be performed by the BAS installer's programmer who programmed the control system for this specific project.
  - b. If any of the demonstrated sequences fails to operate per the controls submittal, take corrective action and demonstrate the failed sequence tests to the Commissioning Authority a second time.
  - c. If the Control Contractor fails to demonstrate proper sequence operation in any of the second round of sequence tests, the Commissioning Authority's costs for witnessing all further demonstration of that sequence may be assigned to the Control Contractor by the Owner as a deduct to their contracted price. The Control Contractor will not be responsible for costs related to failure due to design or to other factors beyond their control, though it is expected to call any design concerns (and other factors beyond their control that might cause failure) to the attention of the Commissioning Authority and the Owner's Representative.
7. Assist Commissioning Authority with programming of the energy management system for trend logs to support functional performance testing during field testing.



8. Assist Commissioning Authority with execution of the Commissioning Procedures. Commissioning Authority will present test schedule at Progress Meeting at least 1 week ahead of scheduled tests.
  9. The Commissioning Authority, acting with Owner authority, may request the Control Contractor to assist with or perform minor loop tuning adjustments, set point and schedule changes, and other similar minor field corrections.
  10. Recommended changes to the controls sequences, program code, and recommendations for additional points must go through the Owner's Representative and the designer. The designer is the final authority on all recommended sequence changes, and will submit such changes to the Owner's Representative for implementation.
  11. Submit to Owner's Representative, at least two weeks prior to Final Completion, two copies of as-built version of points list, including I/O and virtual points, controls Drawings, program printout, and sequence narratives.
  12. Participate in resolution of problems and deficiencies that are discovered during commissioning.
- I. Duties of Balancer:
1. Attend commissioning portion of Project Meetings as necessary.
  2. Participate in resolution of problems and deficiencies that are discovered during commissioning.
  3. Assist Commissioning Authority with execution of commissioning procedures.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.1 COMMISSIONING PROCEDURES AT THE SITE**

- A. Testing Techniques:
1. Each testing procedure may use a variety of techniques. Generally it is preferred to observe new and existing equipment and systems during normal operation.
  2. When functional and emergency modes of operation occur rarely or seasonally, if possible, simulate the conditions that trigger these operational modes.
  3. Simulation of conditions may involve changing set points, changing schedules, simulating pneumatic system pressures or energy management system voltages and currents, disconnecting power, jumpering contacts, or other such procedures.
  4. Whenever temporary adjustments are made, restore the system to its original condition once tests are completed.
  5. When testing requires observing equipment operation over an extended period, use the building energy management system's trend logging capabilities or independent monitoring equipment.
  6. Do not use the building automation system trend logging in the commissioning process prior to point-to-point checkout by Controls

Contractor and approval of point-to-point checkout by Commissioning Authority.

7. Measurement of room lighting levels during evening hours with only artificial lighting, during mid-morning, around noon and mid-afternoon with only natural lighting and with both natural and artificial lighting. Repeat same measurements following calibration of room daylighting sensor.

B. Commissioning Documentation:

1. The Contractors are required to perform startup and checkout of their systems (prefunctional testing) and document the results. The Commissioning Authority will provide electronic forms that may be used by the Contractors. The Contractors may use their own forms if they contain all the required information on the Commissioning Authority's forms, but prior approval must be obtained.
  - a. Where numeric data is required, a narrative entry or simple check-off is not acceptable.
  - b. Annotate trend logs and monitored data as necessary to clarify meaning, and attach to relevant test reports.
  - c. Do not attach irrelevant data to test reports.
2. The Contractor sends the startup and checkout forms to the Commissioning Authority when they are complete and functional. The Contractor sends a "Certificate of Readiness" with the forms which will signal that functional testing can begin.
3. Starting with prefunctional testing, the Commissioning Authority will e-mail an "issues log" weekly to inform the design and construction team of issues that need resolution. The "issues log" will open and close items as they are discovered and resolved until all items are closed.
4. The Commissioning Authority will assemble all the information from the Commissioning Plan (test forms, trend logs, issues log, and basis of design) into a final Commissioning Report.

C. Coordination of Commissioning and Equipment Startup: Do not initiate functional performance testing for equipment or systems in advance of their startup and checkout by affected equipment or system installers and manufacturers' representatives.

D. Test Acceptance Criteria:

1. Acceptance Criteria are the test results that are required before the mode of performance or inspection item in question will be considered acceptable.
2. Any procedures in Specification Section 23 08 00, Commissioning of HVAC and Section 26 08 00, Commissioning of Electrical, that begin with "Verify that..." have an implied acceptance criterion that the sequence as stated is proven to occur and is documented with visual observation notes, measurements, trend logs, and/or monitored data.
3. Acceptance criteria for other functional modes and checklist items are as stated in each section of the Commissioning Plan.
4. Input will be sought when necessary from the Architect's Engineer to determine if test results indicate compliance with Design Intent.
5. The Commissioning Authority will recommend acceptance or rejection of Commissioned System Work based on test results.

- E. Resolution of Deficiencies:
  - 1. Adjust, repair, or replace defective equipment and systems to meet Commissioning Procedure Acceptance Criteria as directed by Owner's Representative.
  - 2. Inform the Owner's Representative and Commissioning Authority of the date for completion of corrective activities.
  - 3. If the date for completion of corrective work passes without resolution of deficiencies, Owner's Representative reserves the right to obtain supplementary services and equipment to correct the problem as indicated in General Conditions.
  
- F. Rechecking and Retesting Charges:
  - 1. In the event of a second failure of a specific commissioning procedure item or test, the responsible party may be assessed charges by Owner's Representative.
  - 2. Charges will be based on each party's actual expenses, including normal hourly billing rates for preparation, testing, and travel time, and materials, equipment rental, and travel expenses as applicable.
  
- G. Construction and Acceptance Milestones for Tasks Related to Commissioning:
  - 1. Equipment, ductwork, and piping installation.
  - 2. Equipment startup.
  - 3. Pre-functional Checklists.
  - 4. Substantial completion.
  - 5. Point-to-point checkout and sequence testing of controls.
  - 6. Test and balance.
  - 7. Commissioning field testing.
  - 8. Occupant move-in.
  - 9. Final completion.
  - 10. Seasonal testing.
  - 11. Commissioning report submittal.
  - 12. Systems Manual submittal.

END OF SECTION



SECTION 09 52 00 - ACOUSTICAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes factory-finished, fabric-covered acoustical wall panels.
- B. Related Work by Other:

- 1. Gypsum board partition and wall structure.
- 2. Paint finish of wall surface behind and between paneling
- 3. Lighting fixtures and electrical services and connections.
- 4. Other acoustical products.

1.2 SUBMITTALS

- A. Data:

- 1. Manufacturer product specifications and installation instructions for materials and attachment system, including certified laboratory test reports and other data required to show compliance with these Specifications and approval by authorities having jurisdiction.
- 2. Include manufacturer recommendations for cleaning and refinishing fabric, including precautions against materials and methods which may be detrimental to finishes and acoustical performances.

- B. Shop drawings:

- 1. Large scale, dimensioned Shop Drawings showing panel layout on all surfaces to be covered by the work specified herein, and location of wall brackets and clips.
- 2. Identify abutting and supporting materials.
- 3. Locate and identify interfacing materials.

- C. Samples:

- 1. Three samples of a typical panel, with finished edges, mounted on production material in veneer finish specified for final use. Samples size shall be large enough to demonstrate typical and special conditions, but not less than 8 inches by 5 inches.
- 2. Samples of clips.
- 3. Approved samples will serve as Architect's control samples.

- D. Test reports: Complete, unedited test reports for panel system prepared by an independent testing laboratory indicating full compliance with both acoustical and fire resistance performance requirements.

- 1. Fire tests shall be for a complete assembly, including perimeter and longitudinal butt joint framing extrusions, core material, and fabric covering as required by Appendix X of ASTM E 84 (NFPA 255).
- 2. Complete test reports for fabric covering prepared by an independent testing laboratory indicating compliance with specified fire resistance performance requirements.

- E. Certificates: Provide certification from manufacturer of panels attesting to their product's compliance with specified requirements including fire performance and acoustical characteristics.
- F. Warranty: Proposed warranty form.

### 1.3 QUALITY ASSURANCE

- A. Installer qualifications: Manufacturer's licensed authorized.
- B. Code compliance: Materials shall be tested, listed and labeled for flammability, combustibility, and smoke developed by a testing agency approved by authorities having jurisdiction.
  - 1. Fire Performance Characteristics: Provide Solo 8 "no added formaldehyde" acoustic planks with surface burning characteristics as determined by testing panel components in accordance with ASTM E84 test procedures.
  - 2. ASTM E 84 testing must be performed by an independent testing organization acceptable to authorities having jurisdiction.
  - 3. Panels will be finished with Fire retardant clear lacquer.
  - 4. Comply with ASTM E-84:

a.	Classification	Class "A"
b.	Flame Spread:	25 or less
c.	Smoke Developed:	450 or less
- C. Mockup: Where directed, construct a mockup of one complete acoustical wall panel the building.
  - 1. Finish mockup as specified.
  - 2. The Architect will review the mockup under various light conditions for defects and improperly finished joints. Provide a portable light for that purpose when so requested.
  - 3. Make corrections requested by the Architect, or remove and replace mockup when the corrective work is not acceptable.
  - 4. When properly protected and identified, the approved mockup shall remain as part of the Work and will be used as a standard for the remainder of the acoustical panels.

### 1.4 HANDLING

- A. Storage:
  - 1. Coordinate the delivery of the acoustical panels with their installation to minimize storage periods at the site.
  - 2. Protect acoustical panels from excessive moisture in shipment, storage and handling. Deliver in unopened bundles and store in a dry place with adequate air circulation.
  - 3. Do not deliver material to building until "wet work" such as concrete and plaster have been completed and cured to a condition of equilibrium.
  - 4. Prior to panel installation the site must be free of all wet and dusty trades and the climatic conditions stabilized to normal operational levels. Planks shall be allowed to stabilize on site 72 hours prior to installation.
  - 5. Planks must be stored, installed and maintained in a secure ambient environment:
  - 5. maintenance

1.5 CLOSEOUT:

- A. Deliver the following for the Owner's future use.
  - 1. Maintenance stock the fabric installed taken from the same "run" as that used for the Project sufficient to cover 4 panels.
  - 2. Carefully pack the maintenance stock in heavy cardboard cartons, with the contents clearly marked. Include complete manufacturer's cleaning instructions.

1.6 JOB CONDITIONS

- A. Environmental conditions:
  - 1. Do not begin installation until spaces to receive acoustical panels are enclosed and maintained at approximately the same humidity and temperature conditions as planned for occupancy.
  - 2. Maintain temperature and humidity, in the space, as recommended by panel manufacturer.
    - a. Humidity: Between 35% and 55%.
    - b. Temperature: Not to exceed 80 degrees F.
- B. Illumination: Illuminate work areas during installation to provide the same or greater level of illumination required to properly perform the work and as will occur in the room or space after the building is in operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Acoustic Planks shall have noise reduction coefficient values of the following when tested in accordance with ASTM C 423 (Type A and F25 mounting method as defined by ASTM E-795).

Description	Thickness	Frequency (Hz)							NRC	SAA
		125	250	500	1000	2000	4000			
Solo 8-25*	1 5/8"	0.1	0.45	1.03	0.96	0.51	0.51	0.75	0.73	
Solo 8-50*	2 5/8"	0.36	0.97	1.15	0.92	0.71	0.69	0.95	0.95	
Solo 8**	5/8"	0.09	0.12	0.37	0.82	0.68	0.40	0.50	0.50	

\* Type A Mounting (with 1" (Solo 8-25), or 2" (Solo 8-50) fiber glass backer)  
 \*\* Type F25 Mounting (1" (25mm) furring/airspace - no backer)

2.2 ACOUSTICAL PANELS

- A. Manufacturer:
  - 1. Decoustics SOLO 8 "No added formaldehyde" Acoustic planks or equal.
- B. Core: Comprised of a single piece "no added formaldehyde" MDF core of 16mm (5/8") thickness faced with a real wood veneer. The structure is perforated by means of "V" routing

on 5/16 inch centers and intersecting perforations of 5/16 inch diameter on staggered 5/8 inch centers

- C. Veneer:
  - 1. Mahogany veneer, stained and lacquered to match Architects sample.
  - 2. Veneer will be quarter cut, slip matched. Veneer will not be sequenced.
  - 3. Clear lacquer finish to 30% sheen.
- D. Clips: As required by installation conditions. Panels must be fully removable for cleaning and refacing.

### 2.3 FABRICATION

- A. Fabricate panels to sizes and configurations indicated.
- B. Attach facing materials securely to produce installed panels with visible surfaces fully covered and free from blisters, seams, adhesive and other foreign matter.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions and measurements affecting the work of this Section at site.
- B. Correct detrimental conditions before proceeding with installation.

### 3.2 INSTALLATION

- A. Comply with the panel manufacturer's instructions, the approved Shop Drawings, and the following.
  - 1. Install by means of manufacturer supplied clips and a tongue and groove connection on hardwood blocking or metal furring.
  - 2. Plank clips must be located at a maximum of 23-5/8 inches on center. If necessary, formaldehyde free acoustically absorptive material of adequate thickness required to meet the acoustic absorption requirements shall be installed between furring or horizontal wood blocking prior to panel installation.
  - 3. Planks shall be supplied with a black facing on the back side to prevent fiber glass insulation color from "reading" through, and shall be site fabricated to sizes required and neatly fitted to adjacent materials.
  - 4. Trim perimeter as detailed. Installer shall provide for shimming and adjustment as required to maintain consistent alignment of joints and of finished panel faces.
- B. Install panels securely to backing, plumb, level, with undamaged edges, and in alignment with other panels, scribed to fit adjoining work accurately at borders.

### 3.3 CLEANING/REPLACING

- A. Clean soiled or discolored panels after installation.
- B. Remove damaged or improperly installed units and replace with new panels.
- C. Replace fabric and panels damaged beyond satisfactory field repair, as determined by the Architect, with satisfactory materials.

END OF SECTION



## SECTION 10 82 13 – ROOF SCREENS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes:

1. Stand-alone roof equipment screens and supporting steel framework. Screens shall be designed to attach to the roof structure and not the equipment being screened.
2. Roof screen accessories.

B. Related Requirements:

1. Division 03 - Cast-In-Place Concrete: Execution requirements for embedded anchors and attachments for metal fabrications specified by this section in concrete.
2. Division 05:
  - a. Structural Steel: Metal Framing.
  - b. Steel Floor Deck.
  - c. Metal Fabrications: Frames and supports.
3. Division 07: Roof Curbs.
4. Division 09: Paints and Coatings: Field applied paint finish.
5. Division 23: Roof Top HVAC Equipment.

#### 1.2 REFERENCES

- A. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A 1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- D. AWS D1.1 - Structural Welding Code - Steel.

#### 1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate Work with other operations and installation of roofing materials to avoid damage to installed insulation and membrane materials.

#### 1.4 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

- B. Shop Drawings: Layout and erection drawings showing typical cross sections and dimensioned locations of all frames and base supports. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- D. Certificates:
  - 1. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
  - 2. Welder's Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- E. Warranties: 3 signed copies.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer with a minimum five years documented experience in producing pre-manufactured metal-framed equipment screens.
- B. Qualifications:
  - 1. Welders: AWS certified within previous 12 months.
- C. Pre-Installation Meeting:
  - 1. Convene at job site, at least seven calendar days prior to scheduled beginning of construction activities of this section, to review requirements of this section.
  - 2. Require attendance by representatives of the installing subcontractor (who will represent the system manufacturer), the mechanical subcontractors and other entities affected by construction activities of this section.
  - 3. Notify Architect four calendar days in advance of scheduled meeting date.
- D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Locate in area designated by Architect.
  - 2. Construct mock-up, one full screen section wide, including two roof supports.
  - 3. Do not proceed with remaining work until workmanship, color, and location is approved by Architect.
  - 4. Remove mock-up if required by Architect.
  - 5. Accepted mock-up may remain in place.

#### 1.6 HANDLING

- A. Deliver materials to the project site clearly marked for proper identification.
- B. Receive, handle and store materials in conformance with the manufacturers printed instructions.
- C. Store products under cover, in manufacturer's unopened packaging until ready for installation.
- D. Protect materials from exposure to moisture.
- E. Store materials in a dry, warm, ventilated weathertight location.
- F. Protect metal fabrications from damage by exposure to weather.

- G. Handling: Use a forklift or crane to move material. Do not lift the bundles by the metal bands.
1. Fork Lift: Spread the forks as far as possible to balance the load. Drive slowly when moving long bundles over uneven surfaces to avoid tipping the load
  2. Crane: Position the canvas sling straps so that the space between the straps is at least 1/3 the length of the bundle. Use sling straps with looped ends running one end of the strap through the loop at the other end to cinch the bundle when lifted. When setting the load on the roof, put wood blocks under it to protect the roof and allow space to remove the sling straps.
  3. Roof Placement: Spread the bundles and crates out as much as possible to avoid overloading the roof structure. Place the material directly over major supports such as beams or trusses.
  4. Position bundles of tubing parallel to the slope of the roof and block prior to opening to prevent the tubing from rolling down the roof slope when unbundled.

#### 1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Field Measurements: Verify roof screen dimensions and conditions of the installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating equipment enclosure without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

#### 1.8 WARRANTY

- A. Framing System: Provide manufacturer's standard written limited warranty stating that the complete framing system shall be warranted against structural failure due to cracking, buckling, bending, tearing or corrosion arising under normal use and environmental conditions for the coverage period applicable.
1. Products installed on projects located 2 miles or greater from salt or brackish bodies of water shall be warranted for twenty (20) years
  2. Products installed on projects located greater than 1 mile but less than 2 miles from salt or brackish bodies of water will be warranted for five (5) years, except for aluminum, stainless steel or copper Products which will be warranted for twenty (20) years.
  3. Products installed on projects located 1 mile or less from salt or brackish bodies of water will be warranted for three (3) years, except for aluminum, stainless steel or copper Products which will be warranted for twenty (20) years
- B. Panel Finish:
1. Provide written warranty stating that the paint finish applied on all equipment enclosure panels will be warranted against chipping, peeling, cracking, fading, or blistering for the coverage period of twenty (20) years.
  2. Provide warranty signed by the panel manufacturer and paint finish applicator (if separate from manufacturer).

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: RoofScreen Mfg., which is located at: 347 Coral St. ; Santa Cruz, CA 95060; Toll Free Tel: 866-766-3727; Tel: 831-421-9230; Fax: 866-253-0738; Email: request info (info@roofscreen.com); Web: [www.roofscreen.com](http://www.roofscreen.com).

## 2.2 MATERIALS

- A. Round Post Supports: 12 inch tall weldments fabricated from steel tube conforming to ASTM A 500 and cold rolled steel conforming to ASTM A 1008, fabricated with pre-punched holes in base plate for fastening to roof structure. After fabrication, apply minimum 2 to 4 mil baked on powder coat primer. Provide height adjustment with galvanized tube sleeve conforming to ASTM A 500, sized to telescope over outside of round post tube and fastened at desired height with self-drilling, self-tapping screws.
- B. Round Post Cap: Weldments fabricated from AISI Type 304 stainless steel with mill finish fabricated to slip over 2 1/2" sleeve tube allowing adjustable height when used with Round Post Support.
- C. Round PVC Roof Flashing: Fabricated from 60 mil, white, single ply PVC sheet conforming to ASTM D 4434. Provide with base flange that extends a minimum of 5 inches (127 mm) onto the roof surface on all four sides. Hot weld all seams for water tightness.
- D. Roof Flashing: Refer to Division 07 section that specifies the roof membrane.
- E. Base Cap Gasket: EPDM with self-adhesive closed cell foam.
- F. Framing: Carbon steel structural tubing in manufacturer's standard sizes, conforming to ASTM A 500 with manufacturer's standard galvanized coating conforming to ASTM B 117 salt spray testing. Provide with wall thickness as determined by structural calculations.
- G. Connector Fittings: Fabricated from AISI Type 304 stainless steel with mill finish.
- H. Steel Hat Channel: Steel sheet conforming to ASTM A 653, Class SS, with a G90 hot-dip galvanized coating.
- I. Hardware: Bolts, nuts, washers and screws 18-8 stainless steel.
- J. Welding Materials: AWS D1.1; type required for materials being welded.
- K. Panel:
1. Profile: 7.2 rib textured panel.
  2. Base Material: Minimum 24 gauge Galvalume steel sheet, AZ50, conforming to ASTM A 792 for painted panels.
  3. Finish:
    - a. PVDF fluoropolymer, 1 mil, 2 coat, 70 percent.
    - b. Color as selected by Architect from manufacturer's standard color range, 20 colors minimum.
- L. Panel Fasteners: No. 14 self-tapping sheet metal screw. Color coat heads to match panel color.

## 2.3 FABRICATION

- A. Fabricate ends of tubing with flat crimp for connections.
- B. Fit and shop assemble items in largest practical sections, for delivery to site.
- C. Fabricate items with joints tightly fitted and secured.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Fabricate system components so that portions of screen can be dismantled for repairs to equipment being screened and for future roof replacement.
- G. Trim and Closures: Fabricated from 24 gauge metal and finished with the manufacturer's standard coating system.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine area where work will be installed to verify the installation can be performed in accordance with the Drawings and structural calculation requirements without interference from other equipment or trades.
- B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Do not begin installation until conditions have been properly prepared.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Provide for erection loads, and for sufficient temporary bracing to maintain indicated alignment until completion of erection and installation of permanent attachments.
- D. Anchor fabrications to structure as indicated.
- E. Separate dissimilar metals and use gasketed fasteners, isolation shim, or isolation tape to eliminate possibility of corrosive or electrolytic action between metals.
- F. Exercise care when installing components so as not to damage finish surfaces. Touch up as required to repair damaged finishes.
- G. Install flashing boots at base supports as required to provide a watertight connection. Install as recommended by the roof membrane manufacturer.
- H. Remove all protective masking from material immediately after installation.

#### 3.4 CLEANING

- A. Remove all protective masking from framing and trim material immediately after installation. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. Maintain in a clean condition during construction.
- B. Protect installed products until completion of project.
  - 1. Ensure that finishes and structure of installed systems are not damaged by subsequent construction activities.
  - 2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect.

- C. Prior to Substantial Completion: Remove dust or other foreign matter from component surfaces; clean finishes in accordance with manufacturer's instructions.
- D. Replace metal wall panels and framing members that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

## SECTION 26 13 00 - RACEWAYS AND BOXES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

#### 1.2 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets indicated.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

#### 2.2 METAL CONDUIT AND TUBING

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc.
  - 2. Alfex Inc.
  - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 4. Electri-Flex Co.
  - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
  - 6. LTV Steel Tubular Products Company.
  - 7. Manhattan/CDT/Cole-Flex.
  - 8. O-Z Gedney; Unit of General Signal.
  - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. EMT and Fittings: ANSI C80.3.
  - 1. Fittings: Compression type.
- F. FMC: Aluminum.
- G. LFMC: Flexible steel conduit with PVC jacket.

- H. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

## 2.3 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers:
  - 1. American International.
  - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 3. Arnco Corp.
  - 4. Cantex Inc.
  - 5. Certainteed Corp.; Pipe & Plastics Group.
  - 6. Condux International.
  - 7. ElecSYS, Inc.
  - 8. Electri-Flex Co.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT/Cole-Flex.
  - 11. RACO; Division of Hubbell, Inc.
  - 12. Spiralduct, Inc./AFC Cable Systems, Inc.
  - 13. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

## 2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
  - 1. Manufacturers:
    - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
    - b. Thomas & Betts Corporation.
    - c. Walker Systems, Inc.; Wiremold Company (The).
    - d. Wiremold Company (The); Electrical Sales Division.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
  - 1. Manufacturers:
    - a. Butler Manufacturing Co.; Walker Division.
    - b. Enduro Composite Systems.
    - c. Hubbell, Inc.; Wiring Device Division.
    - d. Lamson & Sessions; Carlon Electrical Products.
    - e. Panduit Corp.
    - f. Walker Systems, Inc.; Wiremold Company (The).
    - g. Wiremold Company (The); Electrical Sales Division.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers:
  - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2. Emerson/General Signal; Appleton Electric Company.
  - 3. Erickson Electrical Equipment Co.
  - 4. Hoffman.
  - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.



6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. [RANDL Industries, Inc.](#)
10. [Wiremold-Legrand, Inc.](#)

- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
  1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.
- I. Concrete Boxes: Pre-cast reinforced, size and type as shown; Christy, Brooks or approved equal. All underground boxes shall be provided with traffic grade, spring loaded, bolt-down, steel cover.
- J. [Floor Boxes: Wiremold RFB4, RFB11, Evolution 6AT or Evolution 8AT.](#)

## 2.6 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components provide manufacturer's standard prime-coat finish ready for field painting.

## 2.7 FIRESTOPPING FOR LOW VOLTAGE SLEEVES

- A. Firestop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
  1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows.
- B. Fire Rated Cable Pathways: STI EZ-PATH™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
  1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.
  2. Specified Technologies Inc. (STI) Mini EZ-PATH™ Fire Rated Pathway.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors:
  1. Exposed: Rigid steel or IMC.
  2. Concealed: Rigid steel or IMC.
  3. Underground, Single Run: RNC.

4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R.
7. Underground duct bank conduit spacers.
8. Backfill materials per civil site requirements.

B. Indoors:

1. Exposed: EMT.
2. Concealed: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
  - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Minimum Raceway Size: 3/4-inch trade size.

1. [Audio/Visual and Data systems, minimum 1 1/4" trade size.](#)
2. [All other power and low voltage systems minim 3/4" trade size.](#)

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
3. For Outdoor Use – conduit hub, NEMA 4 for conduit connection/terminating to cabinet/panel/boxes.
4. All connectors to be steel. Die cast connectors are not acceptable.

E. Do not install aluminum conduits embedded in or in contact with concrete.

### 3.2 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
  1. Install concealed raceways with a minimum of bends in shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  2. Space raceways laterally to prevent voids in concrete.
  3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.
  2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors on all raceways 2" and larger.
- K. Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
  2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- N. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where otherwise required by NFPA 70.
- P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- Q. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

- R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- S. Set floor boxes level and flush with finished floor surface.
- T. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

### 3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

## SECTION 26 53 10 – EXHIBIT LIGHTING SYSTEM

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. General

1. Provide R21 Strand Power Raceway and ~~for use with future 3<sup>rd</sup> party compatible-DMX512~~ dimming system.

#### 1.2 SUBMITTALS

- A. Product Data: Provide complete submittals and shop drawings with required components and mounting hardware.
- B. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Strand Lighting or approved equal.

#### 2.2 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.

#### 2.3 R21 POWERED RACEWAY

##### A. GENERAL

- ~~1.~~ The powered raceway shall be fully digital and designed specifically for entertainment lighting applications, and shall consist of power distribution raceway as specified on the system drawings and this specification.
- ~~1-2.~~ The powered raceway shall be compatible with future 3<sup>rd</sup> party software for DMX controls. Manual on/off switch controls shall be provided and connected to the system for general on/off only controls when user control system is not connected.
- ~~2-3.~~ System setup and preset data shall, as standard, be fully user programmable on a per raceway or system wide basis.

**B. MECHANICAL**

1. Each raceway shall be formed of cold-rolled steel sections. Exterior surfaces shall be finished in fine-textured, scratch-resistant powder coat paint. Interior surfaces shall have a corrosion-resistant finish.
2. Raceway sections shall be 8' long. Height of each section shall not exceed 6". Width of each section shall not exceed 3-1/2". Overall length of combined sections shall not exceed 96' long. Each Intelligent Raceway shall produce no mechanical noise.
3. The dimming system shall meet or exceed FCC 'Class A' standards for RFI/EMI emissions.
4. A variety of hangers shall be available to mount the raceway to rigging systems, walls or catwalks.
- 4-5. The raceway shall include single pipe hangar and 1 1/2" schedule 40 black pipe as specified on the system drawings and this specification
- 5-6. The system shall be UL and cUL listed and approved.

**C. INSTALLATION**

1. The raceway shall be factory pre-wired and dressed. The contractor shall provide and terminate all feed, load and control wiring on screw terminals fitted within the raceway.
2. All terminations and internal wiring shall be accessible via a removable front cover panel. The Processor Module shall be accessible for programming at all time.
3. Mounting brackets for wall mount and attachments for a wide range of rigging systems shall be provided as specified.

**D. ELECTRICAL**

- ~~1. The power efficiency of the dimmer cabinet shall be greater than 97% at full load. Voltage drop shall not exceed 3 volts.~~
1. Power inputs shall be installed every 3 feet at light locations shown on drawings
2. The system ground shall be made at a grounding lug in raceway termination area.
3. All equipment shall be UL and cUL listed.

~~**SYSTEM ELECTRONICS MODULE**~~

- ~~0. The main dimmer control electronics shall be available in two configurations. A rack mount processor for control of up to 96 dimmers may be centrally located for ease of service and support or processors may be remote mounted directly on the raceway as required.~~
- ~~0. All rack setup and preset data shall be stored in a non-volatile manner and may be transferred to a replacement Rack Processor Module without losing data.~~
- ~~0. Each Rack Processor Module shall have a back-lit LCD display with a keypad for rack setup, preset control, testing, rack status, error and diagnostics.~~
- ~~0. LEDs shall indicate "Network Connection", DMX512 input and Power~~
- ~~0. All rack setup and preset data shall be transferable to and from a networked library storage device on a per rack or system wide basis.~~
- ~~0. The Processor Module shall be permanently mounted in an equipment rack or on the raceway itself as required. The processor shall provide all necessary low voltage signal connections. The processor shall provide the only point for contractor connection of control input connections. The contractor connections shall be made with two screw terminals or crimped RJ45 connectors for ease of installation.~~
- ~~0. Systems with remote mounted processors shall connect to the Powered Raceway over Belden XXXX 3 pair cable in a daisy chain. An optional data splitter for star wiring shall also be available.~~
- ~~0. All DMX512 input connections shall be optically isolated from all processor electronics by a minimum of 2,500V-RMS isolation.~~
- ~~0. The Rack Processor shall support up to 96 dimmers.~~

~~**PROCESSOR CONTROL AND COMMUNICATIONS**~~

- ~~0. The control electronics shall provide the following control and communication inputs as standard:~~
- ~~0. An Ethernet control input. This input can support a connection to a Strand ShowNet system, and shall be supplied Advanced Network Control (ACN) ready. Each Ethernet control input can generate Reporting messages for the dimmer rack. This input shall also allow for local connection to a personal computer, providing setup, playback, library storage, dimming reporting features, and the ability to load rack operating software.~~
- ~~0. One optically isolated DMX512 control inputs.~~

#### ~~PROCESSOR, FEATURES~~

- ~~0. The rack electronics shall provide two levels of operator interface:
 
  - ~~. A local standard interface that includes 6 menu keys and a bitmapped backlit LCD display (minimum 20 character x 4 line) to access standard system menus.~~
  - ~~. A networked customizable Web based interface that includes status displays, configuration and maintenance utilities, integrated on-line help system, and alert emails. Support for wireless PDA's shall allow query and control functions.~~
  - ~~. Each RPM will be imbedded with a unique serial number and password system.~~~~
- ~~0. The dimmer control electronics shall have 16 bit (minimum) fade processing and a dimmer update rate better than 16 ms (60 Hz) or 20 ms (50 Hz). Dimmers set to the same level shall output within +/- .5V of each other, regardless of phase or input voltage, providing the desired level is less than the phase input voltage less the dimmer insertion voltage.~~
- ~~0. As a standard, dimmer rack status reporting shall report the following conditions/data:
 
  - ~~. Present power line voltage~~
  - ~~. Connected lamp wattage~~
  - ~~. Present output setting~~
  - ~~. Dimmer operating temperature~~
  - ~~. Dimming mode~~
  - ~~. Overload condition~~
  - ~~. No load condition~~
  - ~~. Focus mode~~~~
- ~~0. The control electronics shall provide the following setup functions that shall be user programmable on a per rack or system wide basis:
 
  - ~~. DMX512 Port A patch.~~
  - ~~. Set dimmer max. voltage (12V - 260V in 1V steps).~~
  - ~~. Set dimmer min. level (0 to 99%).~~~~
- ~~0. The DMX512 shall support a rack start address and individual dimmer patch.~~
- ~~0. It shall be possible to load new rack operating software via the Ethernet connection to the dimmer rack. There shall be no requirement to turn power to the rack off during the loading of rack software. It shall be possible to load new rack operating software into the processor, regardless of the state of the program storage.~~
- ~~The Low Voltage LED cove lighting system shall consist of DMX512A compatible, individually addressable, modules with a 140° x 140° beam angle, each being 12.125" or shorter. The RGB system must allow 16-bits of precision per color and 48-bits per fixture. The warm white light system allows for 16-bits of precision for each fixture.~~

#### 2.432.4 POWER MODULES

## A. GENERAL

1. The dimmers shall use IGBTs (Insulated Gate Bipolar Transistors) to regulate and control load voltage. Dimmers using hard-switching semiconductor devices, such as SCRs or other thyristors, shall not be acceptable. The dimmers shall not use filter chokes to control the rate of rise in the load current waveform.

## B. ELECTRICAL

1. ~~Each dimmer module shall contain two dimmers, each capable of controlling~~Provide DMX Headend and DMX output plates, quantity required for locations shown on plans. Shall be capable of a 19202400 watt load and be installed every 3 feet adjacent to power inputs. Total load capacity of each dimmer module shall be capped at 20 Amps. If the load capacity is exceeded, the module shall automatically turn-off the last load energized
2. Dimmer electronics shall be completely solid state.
3. The dimmers shall be immune from damage caused by output short-circuits between load and neutral or load and ground.

## C. PERFORMANCE

1. ~~The insertion loss (voltage drop across the complete dimmer at full load current while producing a full output sine wave) shall be less than three volts RMS. Insertion loss at reduced dimmer loading shall not vary significantly from that produced with a full rated load. Dimmers with insertion loss greater than three volts RMS at full rated load shall not be acceptable.~~
2. ~~The dimmers shall use Digital Power Envelope Processing to regulate dimmer output to within +/- 0.5 volts RMS of the assigned setting. Regulating response shall occur in the same power line cycle as the disturbance when the dimmer is in Reverse Phase Control (RPC) mode.~~
3. ~~The system shall provide status information to any Strand Lighting network control console. The following information shall be reported:~~
  - a. ~~Present power line voltage~~
  - b. ~~Connected lamp wattage~~
  - c. ~~Present output setting~~



~~d. Dimmer operating temperature~~

~~e. Dimming mode~~

~~f. Overload condition~~

~~g. No load condition~~

~~h. Focus mode~~

~~4. The dimmers shall hold last received level for a pre-specified period, should the control signal be interrupted.~~

~~5. Dimmer Modules shall automatically switch from Reverse Phase Control (RPC) mode to Forward Phase Control (FPC) mode when inductive loads are detected. In RPC mode the dimmer is on from the beginning of the half-cycle until the desired output voltage is reached. In FPC mode, the dimmer turns on within the half-cycle and stays on until the end of the half-cycle. Use of RPC mode, when load type and other conditions permit, reduces the level of lamp filament noise.~~

~~6. The system shall also support a low harmonics mode that shall reduce harmonic currents present on the feed neutral conductor by automatically switching the dimmers in the system to an optimum configuration of FPC and RPC operation. The reduction in neutral current shall be a minimum of 33% with a maximum of 100%, depending upon load sizes and their associated levels.~~

~~7. When in RPC mode, dimmer output voltage transition time is measured as "fall time". The actual "fall time" generated shall not be affected by the size of the load present. Dimmers shall provide a minimum fall time of 800  $\mu$ S under normal load current regardless of load.~~

~~8. The dimmer transfer function shall comply with the industry standard Square Law dimming curve within a tolerance of +/- 0.5 Volts RMS for all incandescent loads.~~

~~9. Each dimmer shall have an associated Focus push button that provides local ON/OFF/LEVEL control for focusing, maintenance and other purposes. If the level set for a dimmer is zero, tapping the Focus button shall set the dimmer output to full. Pressing and holding the Focus button ramps the dimmer output up to any intermediate level. When a non-zero level is received from the controller, the dimmer shall return to normal operation. Tapping the Focus button a second time shall also return the dimmer to normal operation. If a dimmer already has a non-zero level from the control desk, the Focus button flashes the dimmer to full output. In all cases, activating the Focus button shall be reported to the system operator, at the console or system monitor.~~

~~10. Each dimmer shall have an LED display to facilitate local reporting of operating conditions.~~

~~11. Each dimmer will detect operating conditions and take active measures to protect itself (and the load). Protective measures shall include, but are not limited to the following:~~

~~a. At power-up, each dimmer will detect line voltages in excess of 180 VAC. When over-voltage is detected, the dimmer will not turn on its load. The dimmer will also notify the operator and flash its locally mounted LEDs. Dimmers shall withstand line voltages up to 230 VAC for an indefinite period and up to 280 VAC for fifteen minutes with no damage.~~

~~b. Each dimmer shall detect~~

~~-excessive heat sink operating temperatures and notify the console of the condition via system status reporting. The dimmer shall automatically reduce its own "fall time", which minimizes the production of heat. Dimmers will step from 800  $\mu$ S to 250  $\mu$ S. If heat continues to rise, the dimmer will shut down, notify the console via IPS Talkback and flash its locally mounted LEDs.~~

~~c. Each dimmer shall detect load current in excess of its own rating. An overload will cause a dimmer to shut down, notify the console and flash its locally mounted~~

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

~~B. No cuts are to be made into the dome panels. All cuts into cove trough shall be planned with Astro-Tec manufacturing to insure quality cuts. No cabling shall be visible by walking, standing or sitting audience members. The system shall include all necessary signal cables and mounting hardware.~~

**END OF SECTION**

## SECTION 27 00 01 - COMMUNICATIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section includes general information that applies to all Division 27 specifications.
- B. Related Sections:
  - 1. 27 05 26: Grounding and Bonding of Communication Systems
  - 2. 27 05 36: Communication Cable Pathways
  - 3. 27 08 10: Optical Fiber Testing and Measurement
  - 4. 27 08 20: Copper Testing
  - 5. 27 11 00: Communications Equipment Room Fittings
  - 6. 27 13 00: Communications Backbone Cabling
  - 7. 27 15 00: Communications Horizontal Cabling
  - 8. 27 16 00: Communications Connecting Cords Devices & Adapters

#### 1.2 REFERENCES – TO BE CONSIDERED AS A PART OF THIS SPECIFICATION

- A. Most recent editions and addenda of the following documents:
- B. TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
- C. TIA-526-14-B Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fibre-Optic Communications Subsystem Test Procedure-Part 4-1: Installed cable plant- Multimode attenuation measurement
- D. TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
- E. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
- F. TIA-568-C.2 Balanced Twisted Pair Cabling Components
- G. TIA-568-C.3 Optical Fiber Cabling Components Standard
- H. TIA- 568-C.4 Broadband Coaxial Cabling and Components Standard
- I. ANSI/TIA/EIA 569-B Commercial Building Standards For Telecommunications Pathways And Spaces
- J. TIA-598-C Optical Fiber Cable Color Coding
- K. ANSI/TIA/EIA 606-B The Administration Standard For The Telecommunications Infrastructure Of Commercial Building
- L. ANSI/NECA/BICSI—607A - Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
- M. ANSI/TIA--607-B & B1 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

- N. TIA-758-B Customer-Owned Outside Plant Telecommunications Infrastructure Standard
- O. ANSI/TIA/EIA-862 Building Automation Systems Cabling Standard for Commercial Buildings
- P. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers
- Q. TSB-4979 - Practical Considerations for Implementation of Encircled Flux Launch Conditions in the Field. This bulletin outlines precise specifications that define the launch condition of test sources into multimode fiber which have been standardized and are mandatory for testing optical attenuation of installed multimode cabling per TIA-568.
- R. BICSI Telecommunications Distribution Methods Manual (TDMM) 11th Edition
- S. BICSI Information Transport Installation Manual (ITSM)
- T. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM).
- U. Building Industry Consulting Service International (BICSI) Customer Owned Outside Design Manual.
- V. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premise
- W. IEEE 802.3 Standard for Information technology -Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
- X. IEC 61156-1, Multicore and Symmetrical Pair/Quad Cables for Digital Communications – Part 1: Generic Specification, 2005
- Y. NFPA-70 National Electrical Code 2008 edition
- Z. NECA/BICSI-568-A Standard for Installing Commercial Building Telecommunications Cabling
- AA. NESC – National Electrical Safety Code
- BB. Federal Communications Commission Part 15 and Part 68
- CC. UL 444 – Standard for Safety of Communications Cable
- DD. UL 1666 – Standard for Safety of Flame Propagation Height
- EE. NFPA 262 – Flame Travel and Smoke of Wires and Cables
- FF. Local Authority Having Jurisdiction

### 1.3 DEFINITIONS / TERMS / ACRONYMS

- A. ANSI American Northern Standards Institute
- B. AWG American Wire Gauge

- C. BICSI Building Industry Consulting Service International
- D. BCT Bonding Conductor for Telecommunications
- E. COTS Common Off The Shelf Technologies
- F. EIA Electronics Industry Alliance
- G. ETL Intertek Semko Labs
- H. FCC Federal Communications Commission
- I. IEC International Electrotechnical Commission
- J. IEEE Institute of Electrical and Electronic Engineers
- K. IDC Insulation displacement contact
- L. ISO International Standards Organization
- M. J-STD Joint Standard
- N. NECA National Electrical Contractors Association
- O. NFPA National Fire Protection Agency
- P. NRTL Nationally Recognized Testing Laboratory
- Q. SC TIA Standard duplex connector
- R. TIA Telecommunications Industry Association
- S. UL Underwriters Laboratory
- T. As Necessary: That work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
- U. As Required: That work which is required for completed construction and is shown on the drawings or described in the project Specification.
- V. Cabling: Cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.
- W. Backbone: A facility (e.g., pathway, cable or conductors) between telecommunications rooms, or floor distribution terminals, the entrance facilities and equipment rooms within or between buildings.
- X. Backbone Cabling: Cabling and connecting hardware that provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities.
- Y. BICSI: Building Industry Consulting Service International.
- Z. Concealed: Hidden from sight, buried as in chases, furred spaces, shafts, fixed ceiling or embedded in construction.

- AA. Contractor: The installation Contractor responsible for the furnishing and installation of all work indicated within this Specification.
- BB. Construction Manager: The Owner's appointed representative.
- CC. Equipment Outlet (EO): A device also known as the outlet or information outlet placed at the user workstation for termination using connectors (jacks) of horizontal media for connectivity of data and voice at teacher work area outlet, multimedia equipment. These outlets provide the connection point to voice, data, and other media services.
- DD. Exposed: Bare, open to the elements, out in the open, uncovered.
- EE. Furnish: Purchase, supply, provide and deliver to the project site, protect and provide interim storage and be ready for unloading, unpacking, assembly, installation, and similar operations in accordance with Manufacturer's specifications."
- FF. GE Grounding equalizer: Employed in a multistory building to interconnect multiple TBBs on the same floor. Sized equal to TBB.
- GG. Horizontal Cabling: Cabling between and including the work area outlet/connector and the horizontal cross-connect/patch cord in the telecommunications room.
- HH. Install: Describes operations at project site including the actual "unloading, unpacking, rigging in place, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations".
- II. Installer: Contractor, Subcontractor and/or supplier who uses their own employees for performance of all construction activity related to their specified responsibilities, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform and the "Installers" must be an authorized Manufacturers representative, certified, experienced and qualified to provide, install, program, troubleshoot, train, warrant and service all the systems in this section in their entirety.
- JJ. If Applicable: That work which may be required for completed construction at applicable locations, but is not necessarily shown or described in the Contract Documents.
- KK. Owner: Person or entity for which the building and construction is being done; and/or that will take possession of the property once the construction is complete.
- LL. Owner Representative: The person or entity representing the Owner on contractual matters.
- MM. Product: Any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- NN. Provide: To "furnish and install, complete and ready for the intended use".
- OO. RCDD: Registered Communications Distribution Designer (RCDD).
- PP. Substantial Completion: The project is sufficiently complete to be utilized for its intended use as stated in the body of this written Specification.
- QQ. TBB: Telecommunications Bonding Backbone

RR. TGB: Telecommunications Grounding Busbar

SS. TMGB: Telecommunications Main Grounding Busbar

TT. Words in the singular: Will also mean and include the plural, wherever the context so indicates, and words in the plural will mean the singular, wherever the context so indicates.

## 1.4 SUBMITTAL REQUIREMENTS

### A. General

1. Provide required submittals in accordance with Conditions of the Contract, and Division 1 Submittal Procedures Section.
2. Format:
  - a. For this section furnish submittal data neatly bound in an 8 1/2" x 11" folder or binder for each specification section with a table of contents listing materials by Section and paragraph number.
  - b. Project name and address
  - c. Number of submittal
  - d. Name and address of the contractor
  - e. Date of submittal
  - f. Table of contents with material page numbers listed
  - g. Page number of the corresponding specification or drawing numbers in the contract documents.
3. Submittals to consist of:
  - a. Detailed shop drawings,
  - b. Product specifications,
  - c. Block wiring diagrams,
  - d. "Catalog cuts" and data sheets containing physical and dimensional information,
  - e. Performance data,
  - f. Electrical characteristics
  - g. Materials used in fabrication, and material finish.
4. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded.

### B. Material submittals

1. Label each submittal with the Specification Section Number and provide a cover letter or stamp stating that the submittal has been thoroughly reviewed by the Contractor and complies with the requirements of the Contract Documents. Failure to comply with this requirement will constitute grounds for rejection of data.
2. For each product, indicate where it is intended to be installed.
3. **Resubmittals:** Provide a cover letter with the resubmittal that lists the action taken and revisions made to each product submittal in response to Submittal Review Comments, ***indicating the page in the resubmittal that the new information occurs***. Failure to include this cover letter will constitute rejection of the resubmittal package and no review will occur.

### C. Under the provisions of this request for proposal, prior to the start of work the Structured Cabling System Contractor will:

1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this spec.
2. Submit proof from Manufacturer of Contractor's good standing in Manufacturer's program where contractor is authorized by manufacturer to do warranted work.

3. Submit appropriate cut sheets and samples for all products, hardware and cabling.
  4. Work will not proceed without the Owner's approval of the submitted items.
  5. The Structured Cabling Systems Contractor will submit in writing any material substitutions they propose and receive approval from the Owners on all substitutions of material in writing prior to purchase and installation. No substituted materials will be installed except by written approval from the Owner.
  6. Refer to other applicable sections for additional submittals requirements.
- D. Submit a work plan for installation and testing of the structured cabling system, including time lines for milestones, coordination with other trades, etc.
- E. Shop drawings
1. Obtain electronic files containing the contract documents drawing files for use in preparing the shop drawings from the Engineer.
  2. Use of CAD Files: Should the Contractor need the Engineer's CAD files to produce shop drawings and/or as-built drawings, the Engineer requires the Contractor sign a CAD files release agreement.
  3. Submit the following for review and approval prior to the installation of equipment:
    - a. Floor Plans: 1/8 inch scale floor and site plans showing the locations of devices and cable routing paths with cable types and quantity called out.
  4. Submit Shop drawings for the entire structured cabling system, identifying such items as rack fills, cabling pathways and pathway fills, ladder and other cable raceways, coordination with other trades, etc. These drawings and support narratives must completely describe the intended build for the project.
- F. Provide Indexed Project Manual composed of Test Results, As-Built drawings, material cut sheets, maintenance instructions, Parts List (with part numbers) of all materials installed, etc., at the completion of project.
- G. Certification letters from manufacturers of major system components stating the Contractor is an authorized reseller, installer, and extended warranty provider for the specified security systems.
- H. Final close out documents including but not limited to bound indexed test results, project manual that includes such items as manufacturer and contractor warranties, product cut sheets, material submittals, etc.
1. Provide Building Structured Cabling Systems Administration Report indicating TIA/EIA-606 required information.
  2. Hard copy documentation of test results for every cable segment and link in 3- ring binder. Documents will include measured values as well as whether or not the test passed. Contractor shall supply raw test files for all copper and fiber cables tested.
  3. Provide "As-Built" Drawings on AutoCAD Version the same as provided by architect to the Owner. Obtain copy of original Drawings from the Architect.
    - a. "As-Built" drawings indicating location of all equipment including but not limited to work area outlets, patch panels, cross connect blocks, on each segment and cable routing outlet and identifiers. Indicate labeling for each piece of equipment.
    - b. Provide respective copies mounted in each telecommunications room, and the main cross connect.
    - c. As-Built drawings will contain all installed cabling and materials. Outlets will be numbered with each cable associated with the work area outlet.
    - d. Contractor shall provide ACAD and pdf versions of the As-builts.
  4. Place a laminated 1/2 or full size floor plan of these drawing (coordinate with Owner) on the wall of each communications room.



5. Contractor shall provide three (3) copies of all the above documents on electronic media (CD/DVD).
- I. Submit NRTL certification that the structured cabling system meets the transmission requirements of TIA-568-C.0.

## 1.5 QUALITY ASSURANCE

- A. The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The Telecommunications Subcontractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems.
- B. Telecommunications Systems specified shall be engineered, assembled and installed under the direction of a pre-qualified Telecommunications Subcontractor. Pre-qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:
  1. List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.
  2. Installers shall certify that they are manufacturer-authorized or trained for work to be performed.
- C. The Installer (Firm and Employees) will be experienced in the operations they are engaged to perform. Demonstrate at least five years of continuous recent experience on similar projects. The Installer will hold recent, up-to-date licenses, certifications and training certificates in the area the project is located and for the equipment to be installed.
- D. Provide names of contacts from the last five similar projects including the General Contractor, Owner's Representative, Architect and Engineer. Indicate project locations, scope and current phone numbers that the contacts can be reached at.
- E. Qualified Structured Cabling System Installation firms will have demonstrable design and installation training with certifications of competence. Certified training will be industry recognized and at least equal to:
  1. Building Industry Consulting Service International, Inc. (BISCI) Registered Installer.
  2. Registered Communications Distribution Designer (RCDD).
  3. Manufacturer Certified Installer
- F. Provide a full time on site foreman who personally has been certified as described above. Submit all documentation under this Section.
- G. Provide an on-call Project Manager to supervise the project.
- H. Each Foreman and Installer working on this project will be trained to the qualified level as specified by the Manufacturer(s) for installation and maintenance of equipment being provided on this project. The training will consist of at least a minimum of proper installation techniques of their specific equipment in order to have a complete operating system meeting or exceeding the requirements as specified herein. Each Foreman and Installer working on this project will have documentation from the Manufacturer indicating that they have been adequately trained prior to the start of the project. Only Foreman and Installers who have been properly trained and documented by the Manufacturer whose equipment is being provided on this project will be allowed to install.

- I. Separate Qualifications Requirements:
  - 1. Contractor shall be certified by CommScope to provide an installation that will meet the CommScope Enterprise 20-year Extended product warranty and Application Assurance.
- J. Installers will be specifically qualified for each system being installed under this section. Provide documentation for each installer including:
  - 1. State of CA License as required
  - 2. Registered Telecommunications Installer Apprentice Certificate
- K. Maintain at the site an updated copy of the Manufacturer Trained Installers list including a copy of their training documentation from the Manufacturer. This documentation will be made available to the Architect upon request.

#### 1.6 BIDDER QUALIFICATIONS

- A. Bidding Contractor shall be licensed to install telecommunications systems in the state where work will be performed.
- B. Bidding Contractor shall have a minimum of 5 years of experience installing structured cabling for telecommunications.
- C. Bidding Contractor shall have the capability to bond project in its entirety.
- D. Bidding Contractor shall be able to provide insurance at the request of the owner.

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Contractor shall ensure that materials delivery to work area shall be coordinated with construction site manager responsible for materials distribution to all trades.
- B. Contractor is responsible for all materials, tools and vehicles left on the job site.
- C. Contractor shall coordinate a disposal bin for the removal of all trash produced by the Contractor's associated personnel during the project.
- D. Contractor shall ensure materials are stored in an environmental area where:
  - 1. Temperature does not exceed 120 degrees Fahrenheit nor below 32 degrees Fahrenheit.
  - 2. Humidity does not exceed 80%.
  - 3. No direct exposure to sunlight.
- E. Cable shall be stored according to Manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable will be stored off site at the Contractor's expense.
- F. Deliver equipment in individual shipping splits for ease of handling, mount on shipping skids and wrap for protection.
- G. Inspect and report concealed damage to carrier within specified time.

- H. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location will be protected to prevent moisture from entering enclosures and material.
- I. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.
- J. The equipment will be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer will be required to brace the equipment suitably to prevent tilting does that it does not impair the functional integrity of the equipment.

## 1.8 PROJECT CONDITIONS

- A. Environmental Requirements
  - 1. Contractor shall ensure that any pollutants produced during the work are disposed of according to local, state or national regulations. Follow the most stringent guidelines.
  - 2. It is preferred that the Communications Contractor recycle any used or un-used components during the course of the construction project.
  - 3. Coordinate with LEED project manager if cabling system or components will be used for points in a LEED certified project.
- B. Existing conditions
  - 1. Prior to bid, Telecommunications Subcontractor is to visit the existing building and evaluate all existing conditions. Bring to the attention of the Owner and Design Team any cause for concern or apparent conflicts with the contract documents as soon as practically possible.
  - 2. See Section 01 51 33 for Temporary Telecommunications requirements.
  - 3. Contractor shall not proceed with the cabling installation if the site is not protected from water sources or any moisture that would result in cable failure.
- C. Field Measurements
  - 1. Contractor shall coordinate with electrical engineer on project that the main electrical service ground has a resistance to earth of less than 5 ohms.
  - 2. Contractor shall ensure that all grounding buss bars for all equipment network rooms shall have a resistance of less than 1 ohm back to the main electrical service ground.
  - 3. Contractor shall ensure that all field testers have been calibrated from the Manufacturer within 1 year.

## 1.9 PRE-CONSTRUCTION MEETING

- A. If not called by GC contractor shall call a meeting with GC, Owner's representative, design consultant, and others deemed necessary by Owner &/or GC.
- B. At the meeting, project schedule, cable labeling, detailed IDF design, and phasing will be discussed. In addition, any constructability issues, or questions about the bid documents will be presented verbally and in writing. This is in addition to the standard RFI process established by project manual.

## 1.10 SEQUENCING

- A. Contractor shall coordinate with Owner's project manager on sequencing of various trades and construction teams for the lifecycle of the project.
- B. Cooperation and coordination with other trades.
  - 1. The work will be so performed that the progress of the entire building construction, including all other trades, will not be delayed and not interfered with. Materials and apparatus will be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.
  - 2. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work. Furnish and set in place all sleeves, pockets, supports and incidentals.
  - 3. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interferences or to provide adequate clearances for Code and maintenance requirements will be made at no additional costs.
  - 4. Structural elements of the project will not be relocated, altered or changed to accommodate the work without written authorization from the Owner/Architect.
  - 5. Work that is installed before coordination with other trades or that causes interference with the work of other trades will be changed to correct condition at no additional cost to the Owner.
  - 6. Obtain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.
  - 7. Attend project coordination meetings to coordinate work of this Section, pathways, work of other trades phasing and other project requirements.

## 1.11 CONTINUITY OF SERVICE AND SCHEDULING OF WORK

- A. Contractor shall provide a detailed construction schedule with hard dates for completion of roughing in cables, terminations and testing once scheduling sequence has been determined to the Owner's Project Manager.
- B. Cabling schedule shall be in a software program designated by the Owner's Project Manager.
- C. Continuity of all services will be maintained in all areas that will be occupied or temporarily relocated during the construction period. If an interruption of service becomes necessary, such will be scheduled in advance, made only upon consent of the Owner and at a time outside normal working hours as the Owner will designate. The Contractor will schedule the shutdown with seven days in advance. Arrange work to minimize shutdown time.
- D. Should services be inadvertently interrupted, immediately notify the Owner. Be prepared to immediately furnish labor, materials and the equipment necessary for prompt restoration of interrupted service.
- E. Refer to the overall scheduling of the work of the project. Schedule work, process Submittals and order materials and equipment to conform to this schedule and install work to not delay nor interfere with the progress of the project.
- F. Inform General Contractor and Architect immediately of any delays or potential delays. Furnish Manufacturer's letter to verify order date, equipment delays, expected shipment date, order number, and potential remedies to speed up delivery. Any costs to speed up delivery will be implemented at no cost to the project if the equipment or material was not

ordered as soon as possible after Contract award or within the time frames indicated with the Submittals.

- G. Include premium time required to comply with the project scheduling and phasing.
- H. Be aware of, and plan for, project scheduling and phasing. Provide for complete continuous operation of all systems. Coordinate scheduling and phasing with the Architect, Owner, other Trades, and the General Contractor.
- I. Demolition of existing systems being updated will take place only after the new or replacement system is completely installed, operational, tested and certified. This work may be required on a "per-phase" basis.

#### 1.12 POST CONSTRUCTION MEETING

- A. Subsequent to substantial completion and testing, contractor shall call a meeting with GC, Owner's representative, design consultant, and others deemed necessary by Owner &/or GC.
- B. At the meeting, contractor shall present a DRAFT of AS-Built drawings, test results, and any other material contractor deems appropriate to completing the project for review by other attendees.
- C. Any comments or requests for correction shall be noted by the contractor during the meeting. Corrections to all documents shall be made and final copies shall be submitted within 1 week of meeting.

#### 1.13 PROTECTION OF WORK AND PROPERTY

- A. Be responsible for the care and protection of all work included under this Section until it has been tested and accepted.
- B. Protect all equipment and materials from damage from all causes including theft. All materials and equipment damaged or stolen will be replaced with equal material or equipment at the option of the Architect and Owner.
- C. Materials and equipment stored for this project will be protected and maintained according to the Manufacturer's recommendations and requirements and according to the applicable requirements of NFPA 70B.
- D. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen and make good any damage caused.
- E. Use caution to avoid damage to existing work, and to prevent harm to personnel working in all areas.
- F. Observe all safety precautions and requirements for the construction.
- G. The General Contractor and the Installer are responsible for initiating, maintaining, and supervising all safety precautions and requirements during construction.
- H. Coordinate installations with all other trades in order to not damage equipment or cables during construction. Any work that is damaged during construction will not be repaired.

Replace damaged work completely, with no splices in cabling, at no additional cost to the Owner.

#### 1.14 IDENTIFICATION AND LABELING

- A. Label all major elements in communications infrastructure as defined in TIA 606B.
- B. Detailed labeling scheme will be provided by WVMCCD IS during the Pre-Construction meeting.

#### 1.15 COMMISSIONING

- A. WVMCCD District IS shall participate in the commissioning of the cabling infrastructure system. This will include a complete end-to-end test of the installed infrastructure, to ensure each jack and termination is functioning according to the specifications.
- B. Notify District IS 2 weeks prior to testing / commissioning to ensure they can adequately staff the process.
  - 1. Request confirmation of receipt of commissioning notification.

### PART 2 - PRODUCTS

#### 2.1 REFER TO 27 05 26 FOR BONDING AND GROUNDING SPECIFICATIONS

#### 2.2 REFER TO 27 11 00 FOR EQUIPMENT ROOM FITTINGS

#### 2.3 REFER TO 27 13 00 FOR COMMUNICATIONS BACKBONE CABLING

#### 2.4 REFER TO 27 15 00 FOR COMMUNICATIONS HORIZONTAL CABLING

#### 2.5 REFER TO 27 16 00 FOR COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS

#### 2.6 LABELING

- A. Horizontal and grounding cabling: 1" white with black lettering. Dymo Rhino P/N 1734821
  - 1. Approved equal
- B. Backbone cabling: 1" white nylon with black lettering: Dymo Rhino P/N 1734524
  - 1. Approved equal
- C. Racks, patch panels, cabinets, fire stop systems: ½" white permanent polyester with black labeling. Dymo Rhino P/N 18483
  - 1. Approved equal

#### 2.7 FIRE STOP

- A. Fire stop sleeves must not only be UL listed for installed locations, but must also be design to stop the passage of smoke through the device, and by their design, reduce or mitigate the passage of sound through the device.

1. Install fire stop systems that pass into lecture or other spaces that are rated. Ensure system maintains partition's fire and STC rating, while not de-rating or changing the sleeves' UL Listing.
- B. Acceptable Manufacturers: Subject to compliance with requirements, provide products from manufacturers or approved equal as further defined in the Systems and Applications Schedule in Part 3 of this section.
1. Hilti
  2. EZpath
  3. 3M

2.8 CABLE PROTECTION - METAL STUD-PUNCH BUSHINGS

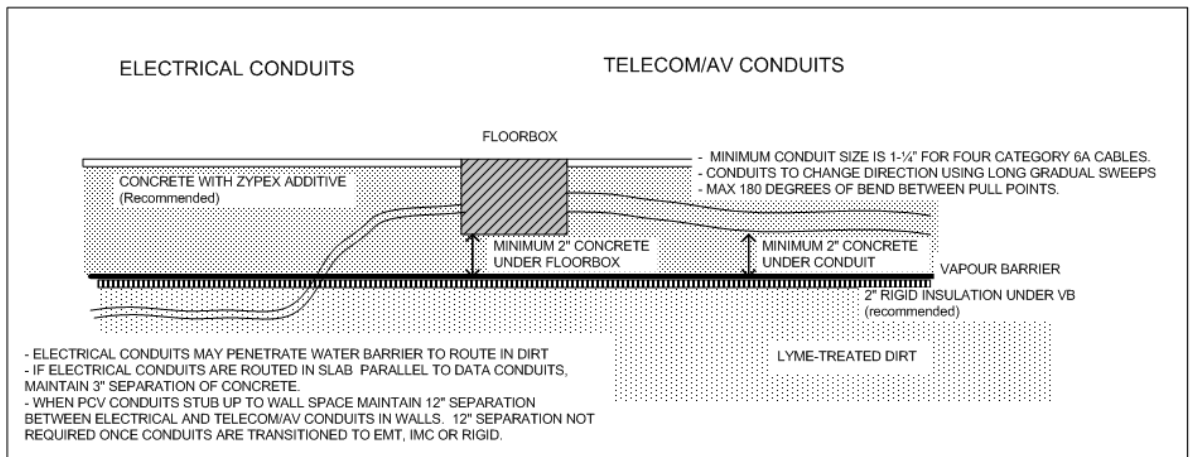
- A. Acceptable Manufacturer
1. Greenlee, 721A
  2. Approved alternate

2.9 CABLE TRAY – ALUMINUM SOLID BOTTOM

- A. Acceptable manufacturer: Cooper, or approved alternate
1. KwikSplice solid bottom, P/N: KSB5A & KSB6A
  2. Utilize 5A for 6" wide, and 6A for 12" wide trays
- B. Provide minimum of 1 divider for all tray, adding dividers as needed.
1. Coordinate with other LVT trades for cable that may be placed in tray to allocate tray space for each.

2.10 FLOOR BOXES

- A. Acceptable manufacturer Legrand
1. EF8S
  2. Approved alternate
- B. Minimum requirements:
1. Sized to terminate Cat 6A data termination ports and power outlets as indicated on plans.
  2. UL listed for scrub water test and 2-hour fire rating while maintaining fire classification of floors.
  3. Refer to electrical for box specs, and Sketch 1 Below:



Sketch 1

PART 3 - EXECUTION

3.1 GENERAL

- A. Verify the exact location prior to bid of all items that may be indicated and determine exact location of all electrical items that are not indicated on the Drawings.
- B. Include the cost of all work including sub-letting of any work that may be required to complete the work indicated in order to avoid work stoppages and jurisdictional disputes. The work to be sublet will conform to precedent agreements and decisions of record. Jurisdictional assignment will be a responsibility under this Section's contractual obligation.
- C. Do not install equipment and materials that have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review will be removed from the project when so instructed by the Architect. No payment will be made for unapproved or removal if it is ordered removed. The Installer will be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.
- D. Obtain detailed information on installation requirements from the Manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents, including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.
- E. Equipment and systems will not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.
- F. Any and all material installed or work performed in violation of above requirements will be re-adjusted and corrected by the Installer without charge.
- G. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets.
- H. Label all equipment as herein specified.
- I. After installation, equipment will be protected to prevent damage during the construction period. Openings in conduits and boxes will be closed to prevent the entrance of foreign materials.
- J. Home runs indicated are not to be combined or reduced without written consent from the Architect.
- K. All connections to equipment will be made as required, if applicable, and in accordance with the approved submittal and setting drawings.
- L. Site Observation:
  - 1. Site observation visits will be performed randomly during the project by the Architect and Owner's Representative. Reports will be generated noting observations.



- Deficiencies noted on the site visit reports will be corrected. All work will comply with the Contract Documents, applicable Codes, regulations and local Authorities whether or not a particular deficiency has been noted in a site visit report.
2. Be responsible to notify the Architect ten working days prior to closing in work behind walls, raised access floors, ceilings, etc., so that installed work can be observed prior to being concealed.
  3. Areas will stay accessible until deficiencies are corrected and accepted. Notify the Architect when all deficiencies are corrected. Return reports with items indicated as corrected prior to re-observation by the Architect.
- M. Change Orders, Modifications, Revisions and Directives:
1. When change orders, modifications, revisions or Architect's Directives are issued or authorized, provide the required additional material, equipment, personnel and workers to prevent delays in the work, and to complete the work within the time limit of the Contract unless a specific time extension is requested with the change and accepted. Include costs for expediting deliveries where required.
  2. Requests for additional compensation will be submitted broken down and associated by item, tasks and Drawing or sketch number with material and labor costs, so quantities can be easily verified.
  3. Requests will be properly and adequately identified so the scope of work can be clearly determined. Indicate who originated change in work.
  4. Submit on all credits broken down as requested for adds. Credits will be separately identified and accounted for. Do not indicate as net changes with adds.
  5. Unit costs for labor and material will be equal for adds, deletes and credits.
- N. Loose materials will not be stored on-site. A "gang box" is acceptable to be placed in a location agreeable to the Owner and the General Contractor. The Installer is responsible for all equipment and materials and for their delivery until the system is deemed complete and accepted by the Owner.
- O. A trailer may be used for the storage of materials to be located on the Owner's property at a location designated by the Owner and the General Contractor. Such on-site storage will be kept locked by the Installer. Security for the trailer and its contents will be strictly the responsibility of the Installer.
- P. Protect existing spaces where work is being performed; protect it from damage and from the accumulation of dirt and debris.
- Q. Any ceilings, walls, floors, furniture, equipment, furnishings, etc., damaged by the work of this Section will be replaced, or at the Owner's option, repaired with similar materials, workmanship and quality.
- R. Work includes field survey of existing conditions, systems, equipment and tracing of existing circuits in order to determine scope of work.
- S. Maintain the existing building in operation at all times during the entire construction period. If it is necessary to have a system shutdown, a written request for approval will be submitted in advance stating the estimated shutdown time. Work will be planned to minimize shutdown. Shutdowns will be at the convenience of the Owner and, if necessary, on premium time.
- T. Clean and touch up all equipment, materials and work sites at the completion of work in each area.

- U. Certain portions of the work area may be occupied during construction. Determine which areas and schedule work accordingly and include necessary premium time.
- V. Make sure necessary provisions to provide continuous service of all existing systems throughout all occupied areas.

### 3.2 CABLE PATHWAYS

- A. Install cables in pathways designed to support the cables per manufacturer instructions.
- B. Provide all equipment and cabling for a complete installed operating system. Cable tray pathways, outlet boxes and grounding are provided by the Electrical Subcontractor unless otherwise noted.
- C. All pathways provided under this Section will comply with fill capacities as per Code, TIA/EIA 569 and BICSI. Coordinate with electrical contractor prior to pathway installation to verify capacity.
- D. Cable bend radius shall not be less than 10 times the diameter of the conduit.
- E. Cabling installed concealed will be supported from the building structure (e.g. cable trays, J-Hooks, etc.).
- F. Cables will be installed no closer than 12 inches (305mm) to electrical equipment and wiring. When cables are required to cross power wiring, they will only do so perpendicular to the power wiring. Cable and power wiring will only cross each other the minimal number of times as required due to building design limitations.
- G. Clearances: Clearances between cabling and other building systems as required by TIA/EIA 569 and BICSI will be maintained throughout the building.
- H. All cables will be installed in a neat and workman-like manner. Cables will be installed parallel and perpendicular to building elements.
- I. Provide expansion fittings and adequate cable slack at all building expansion joints.
- J. Fire/smoke seal around all conduits, raceways, sleeves, slots, etc. where cables pass from one location to another.

### 3.3 FLOOR BOXES

- A. Refer also to AV and electrical documents.
- B. Coordinate with electrical contractor for conduit routing to TR prior to boxes installation.

### 3.4 WORK AREA OUTLETS

- A. All work area outlet locations will be as indicated on the Drawings. Uniquely label each work area outlet and jack within the outlet according to the numbering convention outlined in the section on labeling.
- B. Labeling shall be sequential in order, do not reuse a number throughout the entire infrastructure.

- C. Work area outlets installed in casework will have their cables installed within the conduit or raceway provided.
- D. Install jack and connector modules as indicated in the details and on the Drawings.
- E. Work area outlets will be seated properly and will be installed level on walls and parallel to building elements as required.

### 3.5 INSTALLATION PRACTICES

- A. Follow and adhere to installation practices specified by the applicable Telecommunications Industry Association standards.
- B. Follow and adhere to installation practices specified by BICSI Information Transport System Installation Manual 5th Edition.
- C. Follow and adhere to installation practices specified by BICSI Telecommunications Distribution Methods Manual 11th Edition.
- D. Follow and adhere to installation practices specified by NFPA-70 National Electric Code, Edition 2008.
- E. Follow and adhere to installation practices specified by the Manufacturers.
- F. The general topology will be a "hierarchical star" configuration. All segments will originate in NRTL listed patch panels located in the telecommunication equipment racks/cabinets and end at the work area outlets.
  - 1. Routing:
    - a. All cabling will be installed in conduit.
    - b. Cables will be routed, in large groups, down main cable pathways, until a direct path to the point of access to the workstation outlet can be taken. At that point, cables will be routed, above all building systems, to the outlet location in accordance with standard installation practices, as described herein.
    - c. Multiple cables to individual rooms will be pulled as a bundle and terminated at each end in sequential order so that labeling within a room location is in sequence.
    - d. When not in conduit or tray, cables will be supported to the deck and/or beams, per Part 310 this specification. Hangers, clips, and other methods of grouping the cables and keeping them away from other systems installed in the building are to be provided and installed. Ensure that hangers and other methods of securing cable do not compress cable or damage insulation.
    - e. Cables hanger will be attached to beams prior to fire proofing applications and with minimal disruption of the fireproofing. The Contractor will be responsible for restoring the fireproofing to appropriate levels. Restoration will be verified by the General Contractor. Provide documentation that installation or restoration of fire stop systems is acceptable to Owner and PM.
    - f. Cable routes will be with 90-degree angles whenever possible, following building lines. Cables will not be installed randomly or diagonally through the building, and be supported every 4 feet.
    - g. Cables installed partially or fully within the telecommunications room will be routed through and secured in the cable tray wherever possible. No cables are to be routed across the rooms at angles, or are the cables to be run from one portion of the room or tray to another. Cables placed in the cable tray are to be

- laced frequently to keep them neatly bundled and not permitted to shift from one side of the tray to the other as they are routed in the tray.
- h. Station cables will be routed to fixed wall locations through EMT to back box. Secure and store ten feet of slack cable above ceiling at cable entrance to EMT.
2. Separation from EMI Sources:
- a. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment will be as follows:
  - c. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
  - d. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
  - e. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
  - f. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment will be as follows:
  - g. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
  - h. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
  - i. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  - j. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures will be as follows:
  - k. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - l. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
  - m. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  - n. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
  - o. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).
3. All cables will have both ends completely terminated at their respective patch panel and work area outlet. Individual conductors will be trimmed flush with IDC block.
4. The total length of permanently installed cable for any complete segment will not exceed 250 feet (90m). Do not splice or otherwise re-terminate any cable used, terminate only at the patch panels, cross connect blocks and work area outlets. Route cables [minimum of 12 inches (305mm) away] to avoid light ballasts, transformers, power wiring and other electrical devices so that there is no EMI or RFI interference with data transmission. Permanently label all cables six inches from the connector at each end, according to the numbering convention outlined in the section on labeling. All cables will be terminated at outlets, patch panels or cross-connect blocks ONLY.
5. Maximum pulling tension will not exceed 25 lbs./ft. when installing cables.

### 3.6 LABELING

- A. Document and place on full and half size set of plans all elements with their unique numbers.

- B. All cables will be labeled according to the guidelines as set forth in the EIA/TIA 606-B standard. This shall include:
  - 1. The origination point
  - 2. The destination point
  - 3. The type of cable (SMF, 50MMF)
  - 4. The pair or fiber strand count
- C. Provide a definition or labeling matrix with As-Built/Document Close-Out submittals that defines each labeling element with examples of each field defined.
- D. Submit complete labeling scheme for all elements with initial submittals for project.
- E. Outlet numbering will be supplied by WVMCCD IS. Coordinate outlet numbering in pre-installation meeting before cable installation begins.
- F. Ensure labeling for backbone cables includes information on the space name/number of the cable's opposite end. This requirement includes buss bar, bonding conductor, and bonding backbone cable labeling.
- G. As a part of the close-out submittal package, provide riser cable and bonding conductors drawings (full and half size as well as editable soft copy) showing the cables, their installed routes, and the cable numbers. These documents will be in addition to the As-Built floor plan submittals that identify work area outlet placement with their respective identification numbers.
- H. The Contractor shall confirm specific labeling requirements with the Owner or Owner's Representative prior to cable installation or termination.
- I. Horizontal cables shall be marked at each end, on the sheath indicating the Telecommunications Room and jack number to which the cable is wired.
- J. Backbone cables shall be marked at each endpoint and at all intermediate pull/ access points or junction boxes. Label shall indicate origination and destination Telecommunication Rooms, sheath ID and strand or pair range.
- K. Meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- L. Be pre-printed or laser printed type.
- M. Where used for cable marking, a label with a vinyl substrate and white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than that of the cable to which it is attached.
- N. Where insert type labels are used, provide clear plastic covers to go over label.
- O. Telecommunications Room Naming
  - 1. Each Telecommunications Room will be named and numbered with an individual numeric identifier. The number is assigned by WVMCCD District IS
- P. Fiber Backbone Cable Labels
  - 1. All backbone fiber cables (riser cables) will be labeled at each end of the cable bundle at the furthest point where the sheath is intact (before breakout). If the riser cables pass through multiple pull boxes, Telecommunications rooms and riser openings, they will be labeled at each opening.

2. All outside plant backbone fiber cables will be labeled at each end and in each handhole/maintenance hole that they pass through. Labels will be heat and water-proof so they do not decay when exposed to the elements. All labels must be visible at point of access.
- Q. Labels will be color-coded according to purpose.
1. Fire Alarm – RED
  2. Data – YELLOW
  3. AV – WHITE OR GREY
- R. Optical Fiber Patch Panel Labels
1. Fiber patch panels shall be marked using adhesive labels indicating the range of fibers installed in it. Each panel shall be labeled with the origination and destination Telecommunication Spaces and the strand count. Each fiber strand shall be labeled with a unique strand ID.
  2. All fiber patch panels will be labeled according to the guidelines as set forth in the EIA/TIA 606-B standard. This shall include:
    - a. Name of source Telecommunications room
    - b. Name of destination Telecommunications room
    - c. Fiber pair number
    - d. Riser/Backbone Copper Cable Labels
- S. All outside plant backbone copper cables will be labeled at each end and in each handhole/maintenance hole that they pass through. Labels will be heat and water-proof so they do not decay when exposed to the elements. All labels must be visible at every point of access.
- T. Copper Protector Labels
1. Copper protectors shall be marked using adhesive labels indicating the range of copper backbone pairs installed in it. Each panel shall be labeled with the origination and destination Telecommunication Spaces and the pair count.
  2. All protectors will be labeled according to the guidelines as set forth in the EIA/TIA 606-A standard. This shall include:
    - a. The origination point
    - b. The destination point
    - c. The type of cable
    - d. The pair count
  3. Where protectors terminate multiple backbone pairs, each backbone will be clearly and discretely labeled.
- U. Faceplate/Outlet Labels
1. All faceplates/outlets for station cable terminations will be labeled. This includes wall outlets, wall phones, faceplates in floor boxes and all other termination points. For faceplates equipped with a label trough and plastic cover, the Contractor shall include the jack designation in the label trough.
- V. If upper and lower troughs are available, the Contractor shall divide the jack labeling horizontally, labeling the top two jacks in the upper trough and the bottom two jacks in the lower trough.
- W. All faceplates/outlets will be labeled according to the following guidelines:
1. Name of Telecommunication Space the cable routes to.
  2. Unique faceplate/outlet number, incrementing numerically.

- X. Station Cable Labels
  - 1. Each jack will be.
  - 2. All station cables will be labeled at each end of the cable within 6 inches of the termination. At the patch panel end, all labels must be visible and not be placed inside wire management. Station cables will also be labeled on the faceplate.
  - 3. All cables will be labeled according to the guidelines as follows:
    - a. Name of the Telecommunications room where the cables terminate.
    - b. Faceplate/outlet number
    - c. Jack Type – V for voice and D for data
    - d. Jack label –numeric (1,2) labeled left to right.
  
- Y. Copper Patch Panel Tie Cabling Labels (from XLBET)
  - 1. All ports on the station patch panels shall be labeled with the station cable labels described above. Cables will be terminated in ascending outlet and jack order, and be so labeled.
  - 2. Patch panels which provide cabling connection to voice riser and backbone pairs shall be labeled using a similar convention as the backbone/riser cable labeling. The patch panel will be labeled with the cable name including:
    - a. The origination point
    - b. The destination point
    - c. The type of cable
  
- Z. Labeling procedure will meet EIA/TIA 568C, 606-B (Class 2 Administration) and BICSI Standards.
  
- AA. The labeling scheme will be provided as follows at all locations within the cable infrastructure:
  - 1. Location identification will start from the left, as you walk in the doorway, and continue around the room in a clockwise direction.
  - 2. Labeling shall be sequential in order, do not reuse a number throughout the entire infrastructure.
  - 3. Hand-written and embossed type labels are specifically prohibited. In addition, provide the following:
    - a. Label each outlet with permanent self-adhesive label with minimum 3/16 in. high characters.
    - b. Label each cable with permanent self-adhesive label with minimum, 1/8 in. high characters, in the following locations:
      - c. Inside receptacle box at the work area.
      - d. Behind the communication room patch panel or punch block.
      - e. Use labels on face of data patch panels. Provide facility assignment records in a protective cover at each telecommunications room location that is specific to the facilities terminated therein.
      - f. Use color-coded labels for each termination field that conforms to ANSI/TIA/EIA-606(A) standard color codes for termination blocks.
      - g. Mount termination blocks on color-coded backboards.
      - h. Labels will be machine-printed. Hand-lettered labels will not be acceptable.
      - i. Use industry standard EIA/TIA and BICSI color codes as specified herein and maintain consistent color-coding throughout the building.

### 3.7 FIRE STOPPING

- A. Work, in general, includes furnishing and installing fire and smoke barrier penetration seals for openings in floor, walls, and other elements of construction.

- B. Comply with requirements in Division 07 Section "Penetration Fire stopping".
- C. Comply with TIA/EIA-569-A, Annex A, "Fire stopping."
- D. Comply with BICSI TDMM, "Fire stopping Systems" Article.
- E. Applicator Qualifications: Two years of experience installing UL classified fire stopping.
- F. Performance of materials will have been tested to provide fire rating equal to that of the construction.

### 3.8 SHOP DRAWINGS:

- A. Submit complete shop drawings coordinated where required with work of other sections.
  - 1. Shop drawings shall show layout, spacing, sizes, thicknesses, and types of fabrication, fastening and anchorage details, including welded connections and mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachments to other units or Work, and other details required for proper installation.
- B. Submit shop drawings showing each condition requiring penetration seals indicating proposed UL systems materials, anchorage, methods of installation, and actual adjacent construction.
- C. Include details of cuts, connections, splices, bridging, accessories and other pertinent data required for a complete and proper installation.
- D. Include items not shown and special components and installations not fully dimensioned or detailed in manufacturer's product data.
- E. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
- F. Provide setting diagrams, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.
- G. Submit a copy of UL illustration of each proposed system indicating Manufacturer approved modifications.
- H. Manufacturer's Data: Submit copies of Manufacturer's specifications, recommendations, installation instructions, and maintenance data for each type of material required. Include letter indicating that each material complies with the requirements and is recommended for the applications shown.
- I. Provide stamped drawings and structural calculations signed by a structural engineer registered in the State of installation. Provide calculations for loading and stresses of specially fabricated, designed framing. Clearly indicate all loads imposed on primary building structure.
- J. Existing Project Conditions:
  - 1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
  - 2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.



- K. Materials:
1. Provide materials classified by UL to provide for intended use. For Fire Barriers it must be equal to time rating of construction being penetrated.
  2. Provide asbestos free materials that comply with applicable codes and have been tested in accordance with UL 1479 or ASTM E-814.
- L. Preparation: Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.
- M. Installation:
1. Install penetration seal materials in accordance with printed instructions of the UL Building Materials Directory and in accordance with Manufacturer's instructions.
  2. Seal holes or voids made by penetration to ensure an effective smoke barrier.
  3. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.
  4. Protect materials from damage on surfaces subject to traffic.
- N. Field Quality Control:
1. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.
  2. Keep areas of work accessible until inspection by applicable code authorities.
  3. Perform under this section patching and repairing of fire stopping caused by cutting or penetration by other trades.
- O. Adjusting and Cleaning:
1. Clean up spills of liquid components.
  2. Neatly cut and trim materials as required.
  3. Remove equipment, materials and debris, leaving area in undamaged clean condition.
- P. Environmental Requirements:
1. Furnish adequate ventilation if using solvent.
  2. Furnish forced air ventilation during installation if required by Manufacturer.
  3. Keep flammable materials away from sparks or flame.
  4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by fire stopping materials.

### 3.9 SEALING OF PENETRATIONS AND OPENINGS

- A. Where partition penetration does not require a rated assembly, provide penetrations that maintain partitions' acoustical rating.
- B. All fire stop systems will be installed in accordance with the Manufacturer's recommendations and will be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.
- C. Where possible, utilize fire stop systems that have intumescent material built in as a part of the system.
- D. Where systems with built in intumescent material are not provided, provide a seal around raceways or cables penetrating full height walls (slab to slab), floors or ventilation or air

handling ducts so that the spread of fire or products of combustion will not be substantially increased, and that also maintains partition's STC rating.

- E. Penetrations through fire-resistant-rated walls, partitions, floors or ceilings will be fire stopped using approved systems and methods and NRTL listed products to maintain the fire resistance rating.
- F. Installation restrictions of the listing agencies will be strictly adhered to {e.g. 24 inch (610 mm) minimum horizontal separation between boxes on opposite sides of the wall, maximum square inch opening in wall}.
- G. Fire stopping in sleeves or in areas having small openings that may require the addition or modification of installed cables or raceways will be soft, pliable, non-hardening fire stop putty. Putty will be water resistant and intumescent.
- H. Fire stopping in locations not likely to require frequent modification will be NRTL listed putty or caulk to meet the required fire resistance rating.
- I. Box penetrations into a fire rated wall or shaft will have a fire-stopping pad installed on the back of the box.
- J. Fire stopping of cable trays through walls will be with NRTL listed intumescent bricks to meet the required fire resistive rating and that will not allow products of combustion to pass through the protected opening. The NRTL listed bags will be installed inside and on both sides of the opening as required to meet the required resistive fire rating of the wall.
- K. Fire stopping materials will be NRTL listed to UL 1479 (ASTM E814). Installation methods will conform to a UL fire stopping system. Submit specifications and installation drawings for the type of material to be used. Fire stopping materials will be as manufactured by 3M, International Protective Coatings Corp., Specified Technologies, Inc., Carborundum Company, RayChem, Nelson Fire Stop or approved equal.

### 3.10 WARRANTY REQUIREMENTS

- A. Project Warranty
  - 1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one year from date of project's substantial completion.
  - 2. When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.
- B. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)
  - 1. Beyond the initial one year project warranty, the Copper and Fiber Telecommunications Systems shall be warrantied for a minimum of 20 years by a national and reputable connectivity or cabling manufacturer.
    - a. This warranty shall to cover any material defect, as well as the performance of the cabling system. (Example: A Category 5e cabling system is to deliver 1000BASE-T speed, or 1 "Gig" performance for the entire length of the warranty period.)
    - b. This warranty shall cover both material and labor for the full length of the warranty period.

2. Submit copies of written warranty, minimum of one year, agreeing to repair or replace joint sealers which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted Manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period will be one year from date of substantial completion.
  - a. The Telecommunications Subcontract shall be certified by this manufacturer.
  - b. The following manufacturers are conditionally approved to provide the system warranties (subject to specific project requirements):
    - 1) Copper Connectivity Manufacturer: Systimax
    - 2) Fiber Connectivity Manufacturer: Systimax
    - 3) Cabling Manufacturer: Systimax

### 3.11 CABLE SUPPORTS

- A. Provide hook and loop (Velcro) cable wraps at all panels, equipment racks, cabinets and J-hook supports. Tie wraps are specifically prohibited.
- B. For horizontal cables, secure with minimum required compression in order to secure the cables properly without impeding the signal transmission rating (geometry) of the cable. Hook and loop (Velcro) cable wraps may be used in lieu of cable ties for copper cables only.
- C. Provide J-Hook supports from the building structure as required for cable runs to the cable drop location. Maximum distance between supports will be from 3.5 to 5.5 feet (with spacing randomly determined) depending on the structural elements of the building. Maximum cable count per J-hook is 25 cables. Provide additional supports as required when cable quantities exceed manufacturer's data, and to maintain required bending radius of cables. Cables installed exposed or in areas subject to abuse {below 10 feet (3m) above finished floor} or in accessible areas will be installed in conduit.
- D. All cables will be supported directly from building structure. Under no circumstance will cable be installed using cross bracing, plumbing/sprinkler pipes, ceiling systems or any other system that is not a specifically approved method to independently support cables. Cables will not be allowed to rest on ceiling tiles, duct work, piping, etc. Supports will be provided as required in order for cables to avoid contact with any other building system. Bundle cables in groups by Room.

### 3.12 CABLE PROTECTION

- A. Provide bushings in all metal studs and the like where cables will pass through. Bushings will be of two (2)-piece construction with one piece inserted through the opening and the second piece locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.
- B. Cables to be installed in existing enclosed open bays or furred spaces where conduit stubs are not provided, will be protected from chafing or any damage. The Installer will verify that the warranty will not be violated before installing any cabling in these locations.
- C. Provide cutting, coring, sleeves and bushings and seal as required at all penetrations.
- D. Cables damaged during installation will not be repaired. They will be completely replaced with new cable at no cost to the Owner.

### 3.13 GROUNDING & BONDING

- A. Refer to section 27 05 26 for Grounding and Bonding requirements.

### 3.14 DOCUMENTATION

- A. Label all equipment as herein specified.
- B. In addition to 1.4.H, provide:
  - 1. Building Structured Cabling Systems Administration Report indicating TIA/EIA-606 required information.
  - 2. Hard copy documentation of test results for every cable segment and link in 3- ring binder. Documents will include measured values as well as whether or not the test passed.
  - 3. "Record" drawings indicating location of all equipment including but not limited to work area outlets, patch panels, cross connect blocks, on each segment and cable routing. Indicate labeling for each piece of equipment.
  - 4. Record drawings indicating actual cable routes and outlet identifiers. Provide respective copies mounted in each telecommunications room, and the main cross connect.
- C. Provide "as-built" Drawings on AutoCAD Version 12 or higher to the Owner. Obtain copy of original Drawings from the Architect.
- D. Submit NRTL certification that the structured cabling system meets the transmission requirements of TIA-568-C.0.

### 3.15 CLEANING

- A. In all telecom room spaces - a thorough sweeping, vacuuming and wet mopping shall be performed on a weekly basis or more frequently as directed by the owner. Cleaning shall include floors, rafters, floor joists, exposed structural members, exposed mechanical/electrical equipment and ductwork/piping/conduits, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, or per manufacturer recommendations.
- B. All cable managers and snap covers shall be wiped clean, both inside and outside of front, including rear channels. All clear covers and doors shall be cleaned, both front and rear per manufacturer recommendations.
- C. Inside of fiber optic enclosure and patch panels shall be blown clean of settled dust. Cleaning shall be performed for all new construction projects or where gypsum sanding has been performed.
- D. NOTE: During installation and prior to final handoff to Owner, keep all open fiber and copper ports covered utilizing plastic or tape that leaves no sticky residual.
- E. All scraps, boxes, spools, pull-line and trash shall be removed and properly disposed of.
- F. All residual cable lubricant shall be cleaned from floors and walls with an appropriate degreaser.

### 3.16 PROJECT CLOSEOUT

- A. As above, provide hard copies and electronic media close out submittals as required herein and include the following close out submittals.
  - 1. Operation and Maintenance Manuals
  - 2. Record Drawings
  - 3. Test Reports
  - 4. Warranty certification from Manufacturer's
  - 5. Extra Materials
  - 6. Provide factory calibration report of field test equipment
  
- B. Obtain written receipts of acceptance close out submittals submitted. Receipts will specifically detail what is being delivered (description, quantity and specification section) and will be dated and signed by firm delivering materials and by the Owner's Representative.
  
- C. Provide As-Built drawings indicating actual cable routing and cable terminations including all required identifiers.
  
- D. Provide a half size laminated set of drawings mounted in the Main Equipment Room.
  
- E. All sketches, drawings, and charts herein are for the purpose of providing for specifications in a simplified format. Errors and omissions in such do not relieve the Contractor of the responsibility for providing a fully complete, secure and properly operating structured cabling system suitable for the intended use. Bidders must obtain a complete set of Project Drawings and Specifications to determine the full scope of work. In case of conflict, the Project Drawings and Specifications will prevail.

END OF SECTION



## SECTION 270536 - CABLE PATHWAYS FOR COMMUNICATIONS SYSTEM

### PART 1- GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Wire-basket cable trays.
  - 2. Full bottom trench duct feeder system for in-floor raceway
  
- B. Related Sections:
  - 1. 270000: Communication
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270810: Optical Fiber Testing and Measurement
  - 4. 270820: Copper Testing
  - 5. 271100: Communications Equipment Room Fittings
  - 6. 271300: Communications Backbone Cabling
  - 7. 271500: Communications Horizontal Cabling
  - 8. 271600: Communications Connecting Cords Devices & Adapters

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
  - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
  - 2. Shop Drawings: For each type of cable tray.
  - 3. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
  - 4. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
  - 5. Design Calculations: Calculate requirements for selecting seismic restraints.
  - 6. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
  
- B. Trench duct feeder system and components.

#### 1.3 SHOP DRAWINGS:

- A. For trench duct feeder system and components. Include plans, elevations, sections, details, and attachments to other work.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  
- B. Include scaled cable tray and trench duct layouts and relationships between components and adjacent structural, electrical, and mechanical elements.
  
- C. Vertical and horizontal offsets and transitions.

- D. Clearances for access above and to side of cable trays and duct.
- E. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- F. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
- G. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- H. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- I. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms regularly engaged in manufacture of trench duct feeder and cable tray systems and components of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide trench duct feeder system and cable tray components produced by a manufacturer listed in this section.
- B. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to trench duct feeders and components. Comply with UL 209 "Standard for Cellular Metal Floor Raceways and Fittings." Listed and labeled in accordance with NFPA 70, Article 374 and Canadian Underwriters Laboratories (UL) Standard C22.2, No. 79.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver tray and duct systems and associated components in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to seismic zone 4.
  - 1. Component Importance Factor: 1.5

#### 2.2 CABLE TRAYS – SOLID BOTTOM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Cable Management Solutions as indicated on Drawings
  - 1. Cable Management Solutions: Cooper/B-Line, Thomas&Betts
- B. Description:
  - 1. Configuration: Wires are formed into a wire grid pattern sufficient to support the loads intended.



2. Materials: High strength steel welded wire.
3. Safety Provisions: All wire ends are to be deburred during manufacturing to maintain integrity of cables and installer safety.
4. Straight sections shall be furnished in standard 118 to 120-inch lengths.
5. Wire-Basket Depths: 4-inch usable loading depths.
6. Wire-Basket Widths: 12-inch usable loading widths.
7. Maximum Loads: Not to exceed manufacturer stated load limits
8. Connector/Splicing Assemblies: Use splice plates, CMS model CM 801-SP or functional equivalent to join each tray section to the next tray section-or to intersections.
9. Connector/Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray. Splices shall effectively act as a means to continue the bond from one tray section to the next tray section or tray intersection.
10. Hardware and Fasteners: Hot dipped galvanized

### 2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. If more than one cable tray cover type is required, delete "Covers" Paragraph below and indicate type on Drawings or in a schedule. Retain paragraph if cable tray covers are required. See "Cable Tray Covers" Article in the Evaluations.
- C. Bottom: Solid bottom made by same manufacturer as cable tray.
- D. Indicate required locations for barrier strips on Drawings.
- E. Barrier Strips: Same materials and finishes as for cable tray.
- F. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

### 2.4 WARNING SIGNS

- A. Insert different lettering size in "Lettering" Paragraph below to suit 25-foot (7.6-m) viewing distance.
- B. Lettering: [1-1/2-inch-] <Insert dimension> high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- C. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

### 2.5 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according NEMA VE 1

### 2.6 BASIS-OF-DESIGN FOR TRENCH DUCT:

- A. The design for trench duct feeder systems and associated components is based on the Wiremold® VA Style Trench Duct Feeder System manufactured by Legrand/Wiremold
  1. Trench duct feeder system shall provide large capacity, easy installation and future flexibility for in-floor distribution systems to install electrical and communication

requirements. Fabricate trench duct feeder system from ASTM A653 Grade A steel sheets with G-90 galvanized coating complying with ASTM A653.

2. IN SHOP DRAWINGS, VERIFY THAT THE DUCT PROVIDES SUFFICIENT CROSS-SECTIONAL AREA FOR CABLES AT DIRECTIONAL CHANGES. SUBMIT RFI, CALCULATIONS SHOW INSUFFICIENT AREA.
3. Trench duct Feeder Body and Cover Assembly: VA Series Trench duct; 16-gage galvanized steel 12-inch wide body and 12 inches deep with cover plate. Provide trench duct with extruded vinyl trim, extruded aluminum side rails, stainless steel hold-down screws, 12-gage galvanized steel combination clip assembly, leveling feet, polyolefin lap strip gaskets, support posts, and partitions.

NOTE: This is a special order item with different lead times. Plan accordingly.

4. Cover Plates: 1/4-inch [6.4mm] thick primer painted cover plate [with aluminum trim], width to match trench duct feeder body.
5. Adjustable Partitions: 10-1/2 deep; used to separate trench duct and fitting into three (3) compartments; allow 3/4-inch [19.1mm] upward adjustment; field install on base of trench duct with welds or screws; five (5) foot [1.5m] lengths. Field notched for use in T-Units, risers, and elbows.
6. Support Strips used to provide strength to support cover plate, required for clear spans of 16" [406mm] without partitions or when heavy loads will be used. Field install strip to base of trench duct with welds or screws. Five (5) foot [1.5m] lengths.
  - a. Special order for duct depth
7. End Closures: used to close off end of trench duct; two-piece design allows 3/4" [19.1mm] vertical adjustment. Furnish with two (2) mounting screws.
8. T-Units: used to connect intersecting runs of trench duct at 90 degree angles on three (3) sides; closed side is length. Use partition or tunnel to separate services.
9. T-Unit Tunnels: used to separate three (3) services within T-Unit; attach in field with screws or welds.
10. X-Units: used to connect intersecting runs of trench duct at 90 degree angles on all four (4) sides. Use tunnel and partition as needed to separate services.
11. Access Hoods used to mount service fitting on trench duct in place of a cover plate; removable back plate permits access into the trench duct body.
12. Cover Plate Lifters: Catalog No. 485; used to assist in removal of cover plates from trench duct.

### PART 3 - EXECUTION

#### 3.1 PARTITION PENETRATIONS

- A. All partition penetrations must be light-proof as well as sound proof.

#### 3.2 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.

- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Retain first paragraph below if deleting "Delegated Design" Paragraph in "Performance Requirements" Article. Delete below if retaining "Delegated Design" Paragraph.
- H. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 150 lb.
- I. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- J. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- K. Support bus assembly to prevent twisting from eccentric loading.
- L. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- M. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- N. Support wire-basket cable trays directly from threaded rods or with wall brackets.
- O. Support [center support hangers] [trapeze hangers] for wire-basket trays with [3/8-inch-] diameter rods.
- P. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- Q. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2.
- R. Space connectors and set gaps according to applicable standard.
- S. Make changes in direction and elevation using manufacturer's recommended fittings.
- T. Make cable tray connections using manufacturer's recommended fittings.
- U. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- V. Install cable trays with enough workspace to permit access for installing cables.
- W. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- X. Install warning signs in visible locations on or near cable trays cable tray installation.

### 3.3 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

### 3.4 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fastening cables on horizontal runs is beyond the requirements of NFPA 70 in most cases. See Evaluations.
- C. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- D. Fasten cables on vertical runs to cable trays every 18 inches.
- E. Length of unsupported cable is dependent on the cable diameter. See "Cable Installations" Article in the Evaluations.
- F. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- G. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.
- H. In existing construction, remove inactive or dead cables from cable trays.

### 3.5 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2.

### 3.6 FIELD QUALITY CONTROL

- A. Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
- C. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
- D. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
- E. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
- F. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
- G. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
- H. Check for improperly sized or installed bonding jumpers. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
- I. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

### 3.7 EXAMINATION

- A. Examine conditions under which trench duct feeder system and accessories are to be installed and substrate that will support trench ducts. Notify the [Architect/Engineer] [Construction Manager] in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.8 PROTECTION

- A. Protect installed cable trays and cables.
- B. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
- C. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
- D. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

### 3.9 EXAMINATION OF TRENCH DUCT

- A. Examine conditions under which trench duct feeder system and accessories are to be installed and substrate that will support trench ducts. Notify the [Architect/Engineer] [Construction Manager] in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.10 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards. Locate trench duct feeder system in strict accordance with Drawings in order to maintain electrical module spacing. Remove any burrs or sharp edges on material. Grommet or bush all terminations.
- B. Place trench duct feeder system on supports and adjust to final position with proper end bearing and alignment at the butt joints before permanent attachment. Layout electrical module lines on concrete base in each building bay. Locate trench duct feeder units in strict accordance with Drawings in order to maintain electrical module spacing.
- C. Install 90 degree vertical elbows to connect raceway system to panels and telephone spaces unless indicated otherwise on Drawings.
- D. Provide trench ducts with U-channel or Z-channel vertically adjustable compartment barriers leveled to bottom of cover plate and weld in place on 2'-0" [610mm] centers. Provide support posts independent of compartment barriers for all unsupported cover spans greater than 13 inches [330mm].
- E. Perform a final inspection of the entire trench duct feeder system prior to concrete placement. Seal any gaps in the system with sealing compound recommended by trench duct manufacturer or duct tape to prevent mortar or concrete from entering system.
- F. After placement of concrete fill and before wiring is installed, remove debris and other foreign matter from trench duct feeder system. Cut floor as necessary, following trench duct feeder system manufacturer's recommendations. If moisture is present, remove cover plates from trench duct feeder system as necessary to allow air circulation.
- G. Concrete topping shall be as indicated on Drawings and as specified in Section 03 30 00. Do not use concrete containing chlorides from any source over the top of the trench duct feeder system. Design reinforced concrete in accordance with ACI 318. Concrete placement shall follow proper and accepted industry practice and be in accordance with ACI 304.
- H. Vibrate concrete at all trench duct feeder system components to insure that the concrete completely fills underneath the system. Do not over vibrate the concrete. Shrinkage and temperature reinforcement above the trench duct feeder system shall be in accordance with ACI 318. Take care during concrete placement and, in particular, during concrete vibration to prevent rising of top reinforcement within the slab. Hand finish concrete within a minimum distance of 24 inches [610mm] adjacent to openings so that the top of finished concrete and openings are flush with each other.
- I. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- J. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.
- K. Unused Openings: Close unused box openings using manufacturer's recommended accessories.

3.11 FIELD QUALITY CONTROL

- A. A. Perform field testing and inspection in accordance with Section 01 40 00. The installed raceway system shall be UL Listed under Standard 209 and comply with Article 374 of the NEC, and be certified by the Canadian Underwriters Laboratories under UL Standard C22.2, No. 79.

3.12 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Clean cover plates and prepare for installation of final floor covering. For tile floors, reverse outside tile trim extrusion to the tile position and secure in place.
- C. Protect trench duct feeder system components from damage until acceptance. Do not permit equipment or heavy traffic over trench duct feeder components during construction without first installing ramps over the system components. Design ramps so that imposed loads are not transferred to the system components. Replace system components which are damaged during construction.

END OF SECTION





## SECTION 27 0810 - OPTICAL FIBER TESTING AND MEASUREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes: Products and execution requirements relating to testing and documentation for optical fiber cabling for the communication systems, and supplements requirements found in related sections.
- B. Related Sections:
  - 1. 270000: Communications
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270536: Communication Cable Pathways
  - 4. 270820: Copper Testing
  - 5. 271100: Communications Equipment Room Fittings
  - 6. 271300: Communications Backbone Cabling
  - 7. 271500: Communications Horizontal Cabling
  - 8. 271600: Communications Connecting Cords Devices & Adapters
- C. Specifications and drawing package in its entirety, conditions set forth in base contract, exhibits, etc. as the items pertain to this project.

#### 1.2 WORK INCLUDED

- A. Provide all labor, materials, tools, field-test instruments, and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

#### 1.3 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
- B. This Section includes minimum requirements for:
  - 1. Fiber optic test instruments
  - 2. Fiber optic testing
  - 3. Identification
    - a. Labels and labeling
  - 4. Administration
    - a. Test results documentation
    - b. As-built drawings
- C. 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.

- D. Testing shall be performed on each cabling link (connector to connector).
- E. Testing shall be performed on each cabling channel (equipment to equipment) that is identified by the owner.
  - 1. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- F. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode and singlemode links and channels and OTDR traces and event tables for multimode and singlemode links and channels.
  - 1. Optionally documentation shall also include optical length measurements and pictures of the connector end face.

#### 1.4 DEFINITIONS

- A. See Section 270000

#### 1.5 QUALITY ASSURANCE

- A. Comply with testing procedures and field-test instruments in the applicable requirements of:
  - 1. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
  - 2. ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
  - 3. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
  - 4. ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
  - 5. ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
  - 6. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
  - 7. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
  - 8. ANSI/TIA -568-C.0, Generic Telecommunications Cabling for Customer Premises.
  - 9. ANSI/TIA -568-C.3, Optical Fiber Cabling Components Standard.
  - 10. IEC 61300-3-35, Automated End Face Grading
- B. Field Testing review by owner or owner's representative
  - 1. Provide notification a minimum of five (5) business days prior to field-testing start date
  - 2. A random test sample of the installed links will be compared to contractor supplied test results, if more than 2% of the sample deviates from the contractor's results, the contractor shall repeat 100% of the testing
- C. Testing technicians shall be certified in fiber optic testing including OLTS and OTDR test equipment from an industry manufacturer or industry training organization such as BICSI

#### 1.6 SUBMITTALS

- A. Technician training certifications for fiber optic testing
- B. Manufacturers data sheets and specifications for the fiber optic field-test instruments including:
  - 1. OTDR
  - 2. OLTS

- 3. Endface inspection capture device
- C. Sample test reports.
- D. A schedule (list) of all optical fibers to be tested.
- E. Manufacturer factory cable spec sheet and test results for fiber shipped

#### 1.7 CLOSEOUT SUBMITTALS

- A. Provide test data archive for future maintenance and establish the fiber optic plant baseline.
  - 1. Test shall be organized by media in binders with index and pagination
  - 2. Field-instrument test results documentation
    - a. Provide electronic raw and unaltered data files from the field-test instrument
    - b. Provide the viewing software for the above file
  - 3. Submit a spreadsheet in hardcopy and in an electronic file format acceptable to the owner
    - a. Convert raw data files from the field-test instruments into an archiving utility spreadsheet for the maintenance, and inspection test records.
    - b. Provide the following information about the test in the spreadsheet:
      - 1) Site name as specified by the owner
      - 2) The standard selected to execute the test results
      - 3) Test date
      - 4) Manufacturer, model and serial number of the field-test instruments
      - 5) Version of the test software and the version of the test standards database in the test instrument
      - 6) OLTS Mandel sizes used for each cable type
      - 7) Index of refraction value used for length calculations
      - 8) Names of people performing the testing
    - c. Provide the following information for each tested optical fiber in the spreadsheet:
      - 1) Fiber identification number
      - If this number varies from the cable label, provide a cross reference
      - 2) Length for each optical fiber calculated by the OLTS
      - 3) Length for each optical fiber calculated by the OTDR
      - 4) Automated End Face Grading
      - 5) Test results to include OLTS attenuation link and channel measurements at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
      - 6) Test results shall be submitted to include OTDR link and channel traces and event tables at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
      - 7) A picture or image of each fiber end-face
      - 8) The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements

#### 1.8 TESTING RESULTS

- A. Link attenuation measurement and calculation
  - 1. Link attenuation calculation allowance = Cable Attenuation Allowance (dB) + Connector Insertion Loss Allowance (dB) + Splice Insertion Loss Allowance (dB) where:
    - a. Connector Insertion Loss Allowance (dB) = Number of Connector Pairs × 0.4dB
    - b. Splice Insertion Loss Allowance (dB) = Number of Splices × 0.15dB

- c. Cable Attenuation Allowance (dB) = Maximum Cable Attenuation Coefficient (dB/km) × Length (km)

Optical fiber and cable type	Wavelength (nm)	Maximum attenuation (dB/km)
62.5/125 μm Multimode (OM1)	850	3.5
	1300	1.5
50/125 μm Multimode (OM2)	850	3.5
	1300	1.5
50/125 μm Laser-Optimized Multimode (OM3)	850	3.5
	1300	1.5
50/125 μm Laser-Optimized Multimode (OM4)	850	3.0
	1300	1.0
Singlemode Indoor-Outdoor (OS2)	1310	0.5
	1550	0.5
Singlemode Inside Plant (OS2)	1310	1.0
	1550	1.0
Singlemode Outside Plant (OS2)	1310	0.5
	1550	0.5

**Table 1-1 Optical fiber cable attenuation performance (Ref. TIA-568-C.3 Table 1)**

- B. Field testing cabling links
1. Correct any fiber links that fail attenuation measurement and allowance calculation, or OTDR analysis.
  2. Document all corrective action.
  3. Retest all failed fiber links after corrective action
  4. Provide testing documentation for corrected fiber links
- C. Evaluate Individual connector, splice and fiber insertion loss using the OTDR trace and ensure these components meet or exceed the values in table 1-1

## PART 2 - PRODUCTS

### 2.1 OPTICAL FIBER CABLE TESTERS

- A. Ensure the field-test instrument is updated to the most recent software and firmware provided by the manufacturer prior to testing
- B. Optical loss test set (OLTS)
1. Calculate the length of fiber links
  2. Multimode optical fiber light source
    - a. Provide LED light sources with wavelengths of 850 nm (±30 nm) and 1300 nm (±20 nm)
    - b. Output power of -20 dBm minimum
    - c. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A.
  3. Singlemode optical fiber light source
    - a. Provide dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1500 nm (±20 nm)
    - b. Output power of -10 dB minimum
  4. Power Meter

- a. Provide 850nm, 1300nm and 1500nm wavelength test capability
  - b. Power measurement uncertainty of  $\pm 0.25$  dB
  - c. Store reference power measurement
  - d. Store a minimum of 100 results in internal memory
  - e. External computer interface (serial or USB)
  - 5. Acceptable manufacturers, models:
    - a. Fluke Networks, OptiFiber (OLTS and OTDR combined)
    - b. Fluke Networks, DSX (OLTS; MFM2, SFM2)
    - c. Corning Cabling Systems OTS-613QD (OLTS)
    - d. Exfo, FOT-600 OLTS (OLTS)
    - e. Approved equivalent
- C. Encircled Flux
- 1. Utilized testers capable of encircled flux testing.
    - a. Fluke Certi-Fiber Pro, or approved alternate
- D. Optical Time Domain Reflectometer (OTDR)
- 1. Shall have a color transmissive LCD display with backlight
  - 2. Rechargeable Li-Ion battery for 8 hours of normal operation
  - 3. Internal non-volatile memory and removable memory device with at least 16 MB capacity for results storage
  - 4. Serial and USB ports to transfer data to an external computer
  - 5. Multimode OTDR
    - a. Wavelengths of 850 nm ( $\pm 20$  nm) and 1300 nm ( $\pm 20$  nm)
    - b. Event deadzones typically of 0.5 m at 850 nm and 1.3 m at 1300 nm
    - c. Attenuation deadzones 4.5 m at 850 nm and 10.5 m at 1300 nm
    - d. Distance range 3 km at 850 nm and 7 km at 1300 nm
    - e. Dynamic range 15 dB at 850 nm and 14 dB at 1300 nm
  - 6. Single-mode OTDR
    - a. Wavelengths of 1310 nm ( $\pm 25$  nm) and 1550 nm ( $\pm 30$  nm)
    - b. Event dead zones typically of 1 m at 1310 nm and 1 m at 1550 nm
    - c. Attenuation dead zones typically of 8 m at 1310 nm and 8 m at 1550 nm
    - d. Distance range at least 60 km
    - e. Dynamic range 26 dB at 1310 nm and 24 dB at 1550 nm
  - 7. Acceptable manufacturers, models:
    - a. Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image capture)
    - b. Fluke Networks, **DSX-5000** (QUAD-OTDR)
    - c. Corning Cabling Systems, OV-1000 OTDR
    - d. Exfo, FTB-150 OTDR
    - e. Approved equivalent
- E. Fiber Microscope
- 1. Magnification of 250X or 400X for end-face inspection
  - 2. Video camera and display showing magnified end-face image.
  - 3. Camera probe tips permitting inspection through adapters.
  - 4. Electronic storage of end-face image.
  - 5. Acceptable manufacturers, models:
    - a. Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image  
Corning Cabling Systems, VIP-CCO-K17
    - b. capture)
    - c. Approved equivalent

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. 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.
- B. Provide all labor, materials, tools, and test equipment for the testing and measurement of the installed optical fiber cabling.
- C. Coordinate the optical fiber testing with other applicable trades
- D. Notify the Owner or the Owner's representative of any non-specified tests deemed necessary to guarantee a fully functional system.
- E. Provide system closeout documentation including test measurement results in electronic spreadsheet format and native file format from the test instrument along with viewing software prior to final acceptance
- F. Provide test measurements carried out in accordance with the Tier 2 specification of ANSI/TIA-568-C.0, Annex E, plus an image capture of connector end-faces. Include length measurement, attenuation measurement, verifying polarity (using an optical loss test set (OLTS) and obtaining a trace and event table of the fiber with an optical time domain reflectometer (OTDR)
- G. Perform testing on each optical fiber cabling link (adapter to adapter)
- H. Provide testing documentation for:
  - 1. OLTS dual wavelength attenuation measurements for multimode (850nm and 1300nm)
  - 2. Single mode links (1310nm and 1550nm)
  - 3. OLTS length measurements for multimode and singlemode links
  - 4. OTDR traces and event tables for multimode and singlemode links
  - 5. Image captures of connector end-faces.
- I. Observe safety precautions in ANSI Z136.2 for testing that use lasers or LED light sources
  - 1. High power light sources should not be directly viewed, use indirect viewing by pointing the end of the fiber at an adjacent surface to determine the presence of light
- J. Refer to ANSI/TIA TSB-140 "Additional Guidelines for Field Testing Length, Loss and Polarity of Optical Fiber Cabling Systems" for industry best practices.
- K. Calibrate the field-test instruments as recommended by the manufacturer, or at least within one year of project test measurements. The field-test instrument shall contain the most recent software and firmware provided by the manufacturer prior to testing.
- L. Prior to testing, the labels for all outlets, cables, patch panels and associated components must be in place. Testing performed prior to proper labeling shall be retested
- M. Perform testing on each cabling segment in accordance with ANSI/TIA-568-C.0 Annex E, Tier 2 including:
  - 1. verify polarity
  - 2. measuring length
  - 3. OLTS attenuation measurement
  - 4. OTDR trace analysis

- N. Record an image of each fiber optic connector endface for the closeout documentation
- O. Submit the optical fiber link test results from the OLTS, and OTDR field-test instruments as part of the closeout documentation
- P. Place dust caps on fiber endfaces or adapters on completion of all testing

3.2 OPTICAL FIBER TESTING REQUIREMENTS

- A. OTDR testing
  - 1. Reflective events (connections) shall not exceed 0.75 dB.
  - 2. Non-reflective events (splices) shall not exceed 0.3 dB.
- B. Magnified end face inspection
  - 1. Fiber connections shall be visually inspected for end face quality.
  - 2. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
- C. Perform Automated End Face Grading PRIOR to testing cable plant. Provide test results of this grading.
- D. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. 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 in accordance with Part 3.
- E. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

Note: High Bandwidth applications such as 1000BASE-SX, 10GBASE-SR, and FC1200 impose stringent channel loss limits. Where practical, certification should consider loss length limits that meet maximum channel (transmitter to receiver) loss.

F. Performance specification for MM fiber at 850 nm

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		Fibre Channel 1200-MX-SN-I	
	µm	(MHz•Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)
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

- G. Polarity
  - 1. For duplex connector systems, verify polarity with an OLTS
- H. Length measurement
  - 1. Measure each optical fiber link with the OLTS and OTDR for its length and submit with the closeout documentation
- I. Attenuation measurement (OLTS)
  - 1. General
    - a. Turn on optical light sources for a minimum of 5 minutes prior to referencing.
    - b. Test jumpers shall be reference quality and between 1m and 5m in length.
    - c. Provide mandrels sized per the OLTS manufacturer requirements

- d. Secure the mandrel to the light source and ensure that the fiber jacket is not deformed or damaged
  - e. Reference the light source to the meter a minimum of twice daily
  - f. Fiber test jumpers shall be of the same type, core size and match the performance specifications as the cabling under test
  - g. Clean and allow sufficient time for cleaning solution evaporation, of Fiber test jumpers and fiber links immediately prior to each connection of the test instrument
  - h. Do not remove the test jumper connected to the source after referencing to prevent adverse influence on the attenuation measurement. If the test jumper is disconnected, re-reference to the light source.
  - i. Test singlemode optical fiber at 1310 nm and 1550 nm as referenced in ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper.
  - j. Test multimode optical fiber links at 850 nm and 1300 nm as referenced in ANSI/TIA/EIA-526-14-A, Method B, One Reference Jumper.
  - k. Measured and report attenuation in each direction (averaged in both directions) for both single and multimode fiber links.
2. Testing procedure for multimode and singlemode fiber links:
- a. Multimode fiber test requires a jumper with manufacturer recommended non-overlapping wraps of multimode fiber on a mandrel.
  - b. Singlemode fiber test requires a jumper with a manufacturer recommended loop of singlemode fiber.
  - c. Verify test jumper quality, reference and adjust per manufacturer recommendations

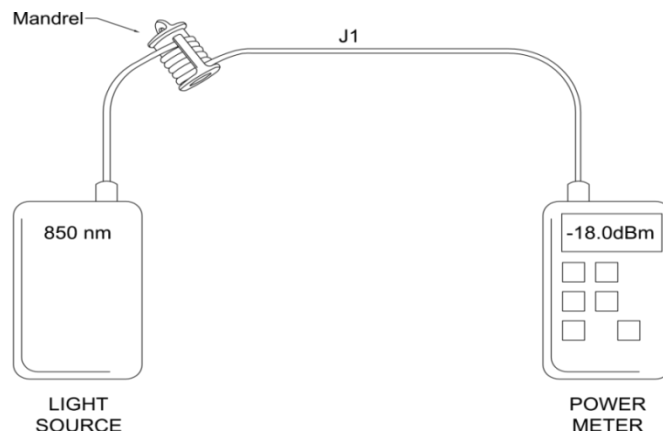


Figure 3-1 – OLTS reference measurement ( $P_1$ ) with one test jumper

- J. Optical fiber endface image
1. Capture and record an image of each optical fiber after completing Tier 2 testing of the optical fiber link using either 250X or 400X magnification
- K. Encircled Flux
1. When testing for encircled flux, ensure proper test laser and test leads capable of testing for EF.
  2. Utilize EF compliant launch fill of fiber
  3. VCSEL lasers are not acceptable
  4. Utilize testers that can give you an automated pass/fail tests.
- L. OTDR trace analysis (figure 3-4)
1. Provide an OTDR trace of each optical fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss



2. Provide and install a launch cable of the same type as the fiber link under test and as specified by the OTDR manufacturer for installation between the OTDR and the first link connection
3. Provide a receive cable, installed after the last link connection as part of the OTDR trace of at least 100m (328ft) in length and of the same fiber type as the link under test

### 3.3 IDENTIFICATION

#### A. Labeling

1. Labeling shall conform to the requirements specified within ANSI/TIA-606-B or to the requirements specified by the Owner or the Owner's representative.

### 3.4 ADMINISTRATION

#### A. Test results documentation

1. 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.
2. 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'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.
3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of the building. This CD-ROM shall include the software tools required to view, inspect, and print any selection of the test reports.
4. Circuit IDs reported by the test instrument should match the specified label ID (see 3.3 of this Section).
5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
  - a. The identification of the customer site as specified by the end-user
  - b. The name of the test limit selected to execute the stored test results
  - c. The name of the personnel performing the test
  - d. The date and time the test results were saved in the memory of the tester
  - e. The manufacturer, model and serial number of the field-test instrument
  - f. The version of the test software and the version of the test limit database held within the test instrument
  - g. The fiber identification number
  - h. The length for each optical fiber
  - i. Optionally the index of refraction used for length calculation when using a length capable OLTS
  - j. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
  - k. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
  - l. The length for each optical fiber as calculated by the OTDR.
  - m. The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
  - n. Optional
    - 1) A picture or image of each fiber end-face

- 2) A pass/fail status of the end-face based upon visual inspection.
  6. Provide summary report of all cables tested in PDF format.
  7. Provide full tester report for each cable tested in PDF format.
- B. As indicated in 270000, all documentation will be provided in soft and hard bound copies. Hard copies are to be included in an indexed binder with each test or document residing in its own section and listed in the table of contents for easy reference.

END OF SECTION

## SECTION 27 0820 - COPPER TESTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes: Products and execution requirements relating to testing and documentation for copper cabling for the communication systems, and supplements requirements found in related sections.
- B. Related Sections:
  - 1. 270000: Communications
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270536: Communication Cable Pathways
  - 4. 270810: Optical Fiber Testing and Measurement
  - 5. 271100: Communications Equipment Room Fittings
  - 6. 271300: Communications Backbone Cabling
  - 7. 271500: Communications Horizontal Cabling
  - 8. 271600: Communications Connecting Cords Devices & Adapters
- C. Test measurements shall be taken for all balanced-twisted pair cabling, including horizontal and backbone copper cables and wall-to-rack cables. Test all category cables in accordance with current TIA measurement specifications for that category of cabling with a field-test instrument meeting or exceeding Level IV accuracy. Provide test measurement results (in electronic format) a minimum of three weeks prior to substantial completion.

#### 1.2 RELATED DOCUMENTS

- A. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS' immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
- B. The following standards:
  - 1. ANSI/TIA-568-C.2 –Balanced Twisted-Pair Telecommunications Cabling and Components Standard
  - 2. ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- C. The following guidelines:
  - 1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
  - 2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

#### 1.3 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with applicable requirements of (or latest publication):
  - 1. ANSI/TIA-568-C.2
  - 2. ANSI/TIA-1152
- B. Test measurements shall be performed by trained technicians who have successfully attended manufacturer training or BICSI Installer 2 copper training.
- C. The Owner or the ITS Representative shall be invited to witness, review or both witness and review field-testing.

1. Notify ITS Representative and Design Engineer of the testing start date, five (5) business days before testing commences.
2. After final test measurements have been completed and submitted, the ITS Representative or Design Engineer will select a random sample of up to 10% of the installed links that the telecommunications contractor is to retest at no cost to the Owner. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor, under supervision of the ITS Representative, shall repeat 100% of the testing at no cost to the Owner.

#### 1.4 SUBMITTALS

- A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
  1. Names of individuals that will be performing the testing and their training certificates (from BICSI or manufacturer).
  2. Manufacturer's cutsheet or specifications sheet for the field-test instrument to be used, along with calibration data sheet.
  3. Sample Test Report, which shall show that the field-test instrument software and firmware is up-to-date (the most recent version). This sample test report shall also show all required test parameters as required by the referenced standards.
- B. The following submittals are due a minimum of three weeks prior to substantial completion, in accordance with the submittal requirements in Section 27 00 00 Communications:
  1. Complete test measurement results indicating that all cable permanent links have passed. Submit (2) electronic versions on (2) CD/DVD-R or USB Flash Drive (one for the ITS Representative and one for the Design Engineer):
    - a. Microsoft Excel 2007 (Manifest)
    - b. Test measurement results in their native format and the manufacturer's PC software to read test results.
    - c. Test shall be organized by media in binders with index and pagination
    - d. Manufacturer factory cable spec sheet and test results for shipped cable.
- C. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
  1. On final electronic file submittal (CD/DVD-R or USB Flash Drive), which is to include record drawings, O&M manuals, etc., also include files for all valid test results (as submitted previously).

## PART 2 - PRODUCTS

### 2.1 FIELD-TEST INSTRUMENT

- A. The field-test instrument shall:
  1. Calibrate the field-test instruments as recommended by the manufacturer, or at least within one year of project test measurements.
  2. Contain the most recent software and firmware provided by the manufacture prior to testing.
  3. Be a Level IV accuracy
- B. Administration
  1. The test measurement result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
  2. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

- C. Manufacturer shall be:
  - 1. Fluke DSX-5000
  - 2. Agilent
  - 3. Or Approved Equivalent

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any test measurements performed on incomplete systems shall be redone on completion of the work.
- B. The records for each cable test measurement shall be provided to the owner a maximum of two weeks after substantial completion in Excel format (manifest) and the native format to the field-test instrument. The Owner can supply an Excel spreadsheet template (manifest) upon request for the contractor's use.
- C. The installed twisted-pair links shall be tested from the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification.
- D. One hundred percent of the installed cabling links shall pass the requirements of the referenced standards. Any failing link shall be diagnosed and corrected. The corrective action shall be noted and followed with a new test measurement to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test measurements results documentation.
- E. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. The test equipment (tester) shall comply with the accuracy requirements for Level IIIe field-test instruments as defined in ANSI/TIA-1152. The field test instrument, including the appropriate interface adapter, shall meet Level IV accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the Channel configuration).
- F. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail\* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass\*. The "\*" shall not be turned off on the test instrument.
- G. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field-test instrument manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '\*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

#### 3.2 PERFORMANCE TEST PARAMETERS

- A. Test parameters for Category 6A cables (up to 500MHz):
  - 1. Wire Map
  - 2. Length

3. IL - Insertion Loss
4. NEXT – Near End Cross-Talk
5. PSNEXT - Power Sum Near End Crosstalk
6. ACRF - Attenuation to Crosstalk Ratio – Far End
7. PSACRF - Power Sum Attenuation to Crosstalk Ratio – Far End
8. PSANEXT - Power Sum Alien Near End Crosstalk
9. PSAACRF - Power Sum Alien Attenuation-to-Crosstalk-Ratio from the Far End
10. RL - Return Loss
11. Propagation Delay
12. Delay Skew

- B. Test parameters for other cables:
1. Continuity to the remote end;
  2. Shorts between any two or more conductors;
  3. Crossed pairs;
  4. Reversed pairs;
  5. Split pairs; and,
  6. Any other mis-wiring.

### 3.3 ADMINISTRATION

- A. Test results documentation
1. 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”.
  2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.
  3. The records for each test shall be provided to the owner a maximum of one week after substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractors use.
  4. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner.
  5. The detailed test results documentation data is to be provided in an electronic database for each tested link and shall contain the following information
    - a. The identification of the customer site as specified by the end-user
    - b. The name of the standard selected to execute the stored test results
    - c. The name of the test personnel
    - d. The date and time the test results were saved in the memory of the tester
    - e. The manufacturer, model and serial number of the field-test instrument
    - f. The version of the test software and the version of the test standards database held within the test instrument
    - g. The copper identification number
    - h. The length for each copper cable
    - i. The overall Pass/Fail evaluation of the channel test.
  6. Provide summary report of all cables tested in PDF format.
  7. Provide full tester report for each cable tested in PDF format.
  8. Ensure that sweep frequency measure graphs are included in reports.
- B. As indicated in 270000, all documentation will be provided in soft and hard bound copies. Hard copies are to be included in an indexed binder with each test or document residing in its own section and listed in the table of contents for easy reference.

END OF SECTION

## SECTION 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes basic communications room requirements, and supplements requirements found in related sections. Refer to "T" series drawings for specific communication room requirements:
- B. Related Sections
  - 1. 270000: Communications
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270536: Communication Cable Pathways
  - 4. 270810: Optical Fiber Testing and Measurement
  - 5. 270820: Copper Testing
  - 6. 271300: Communications Backbone Cabling
  - 7. 271500: Communications Horizontal Cabling
  - 8. 271600: Communications Connecting Cords Devices & Adapters

#### 1.2 SCOPE OF WORK

- A. Provide all labor, materials, tools and equipment required for the complete and proper communications equipment room fittings installation.
- B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the communications equipment room fittings installation with other applicable trades.
- C. In addition to the details specified within this Section, the contractor shall notify the ITS Representative of any additional items deemed necessary to guarantee a fully functional system. The contractor shall furnish and install all necessary items for a fully functional system at no additional charge.
- D. Furnish and install the following:
  - 1. Racks
  - 2. Cabinets
  - 3. Enclosures
  - 4. Cable management panels.
  - 5. Building entrance terminal and protectors.
  - 6. Primary and secondary building entrance protection
  - 7. Surge protection devices
  - 8. Patch panels and other connecting hardware as needed

#### 1.3 DEFINITIONS

- A. Communications room: A generic term for an equipment room or telecommunications room.
- B. Entrance room: A space in which the joining of campus and building telecommunications backbone facilities takes place.

- C. Equipment room: An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect and security equipment.
- D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- E. Telecommunications room: An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling and security equipment.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."
- D. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
- E. Qualification Data: For installers, qualified layout technician, installation supervisor, and field inspector.
- F. Seismic Qualification Certificates: For floor-mounted racks and cabinets, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings will be under the direct supervision of a RCDD.



2. Installation Supervision: Installation will be under the direct supervision of a Registered Technician who will be present at all times when Work of this Section is performed at Project site.
  3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.
  4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA70, by a qualified testing agency, and marked for intended location and application.
- B. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C, or most recent edition of the TIA standard.
- C. Grounding: Comply with ANSI-J-STD-607-B, or most recent edition of the TIA standard.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

#### 1.7 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service providers. Coordinate service entrance arrangement with local exchange carrier.
1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  2. Record agreements reached in meetings and distribute them to other participants.
  3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- C. Electrical Contractor shall furnish and install the following:
1. Power circuits to telecommunications spaces and equipment.
- D. Unless noted otherwise, the following items will be the responsibility of the Owner:
1. All electronics and active data networking equipment, etc.
  2. Telephones, fax machines and modems, etc.
  3. PC's, printers, video display terminals, flat panel displays, etc.
    - a. Contractor shall coordinate with the Owner's network and computer equipment personnel for specific instructions before starting Work.
    - b. Contractor shall coordinate with the General Contractor for location and type of backing to be installed on/in the walls to support wall mounted equipment.
    - c. Contractor shall coordinate location of electrical receptacles to be installed on raceways, racks or inside cabinets.

## PART 2 - PRODUCTS

### 2.1 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-B.
- B. Cable Support: NRTL labeled.
- C. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
- D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
  - 1. Outlet boxes will be no smaller than 5"square and 2.875" inches deep.

### 2.2 CABLE RUNWAYS

- A. Acceptable Manufacturer: CPI P/N 10250-1xx (sized as indicated on drawings), or approved alternate.
  - 1. Type: Cable runway type
  - 2. UL Classified and Listed.
  - 3. Rung Spacing: 12 inches on center.
  - 4. Furnish and install all connectors and fittings, as required. Where cables drop out of the cable tray, "drop-out" fittings shall be furnished and installed.
  - 5. Cable tray shall be approved as a ground conductor or ground conductor clamps shall be furnished and installed for each section with appropriate sized ground wire between sections.
  - 6. Material: Steel.
  - 7. Finish: Black powder coat

### 2.3 BACKBOARDS

- A. The Backboards: A/C grade plywood, void free, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).
- B. Plywood must be kiln dried to a maximum moisture content of 15 percent.
- C. Must be treated on all sides with at least two coats of fire-resistant, painted flat white, with at least one Fire-Rated stamp visible per sheet or partial sheet of plywood.
- D. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry".
- E. Mount ply with smooth side to room interior.
- F. Provide in close-out submittals Bills Of Lading to prove fire-retardant properties of ply and paint.
- G. Secure sheets to studs at regular 18" or fewer intervals with screws penetrating into studs a minimum of 3/4".

### 2.4 CATEGORY 6A PATCH PANELS

- A. Manufacturer – Angled Systimax

1. Separate data and voice patch panels
2. Voice installed above data
3. Label data patch panels D1 & D2, with the D1 cables terminated on D1 patch panel, and D2 cables terminated on D2 patch panel.

## 2.5 SC FIBER OPTIC PATCH PANELS/ENCLOSURES

- A. Manufacturer –
  1. Systimax
- B. Fiber Termination:
  1. Place fiber patch panels at the top of cabinet.
  2. Fiber optic cables shall be terminated with SC Terminations shall be housed in 4U rack-mount enclosures providing protection for the terminated fibers. SC connector shall accept 900µm buffered OS2 single mode fiber
  3. Duplex single-mode shall be no-epoxy/no-polish and terminate with 900um tight-buffered fiber. SC connectors shall meet the most recent revision of TIA/EIA-568-C.3 standard, and its published addenda.
  4. Each SC connector shall be held by a SC duplex coupler snap-in adapter plate. Adapter plates shall be installed into rack-mount fiber optic enclosure.
  5. Fiber optic enclosures shall be 4 U capable of containing 144 SC simplex connectors.
  6. For inside plant, utilize pig tail splicing connectors, and for OSP fiber, utilize fan out kits for termination of the fiber.

## 2.6 COPPER CABLE SPLICING

- A. Copper Splice Enclosures
  1. Acceptable Manufacturer: Performed Line Products Armadillo Series, or approved equal.
    - a. Re-enterable, stainless steel closure with a neoprene liner.
    - b. Minimum size as required to support the quantity and configurations of cables and splices.
    - c. Appropriate end plates and washers as required to accommodate the various cable diameters and quantities.
    - d. Drillable end plates as required to support cable quantities and configurations other than supported by pre-manufactured end plates.
    - e. End plates shall be provided with ground connection point.
    - f. Size the closure based on splice quantity and end plate diameter requirements.
    - g. Size drillable end plates based on cable O.D., quantity and manufacturers recommendations.
    - h. Furnish and install the bonding kit to bond all cable shields that enter closure.
    - i. Furnish and install mastic sealing tapes and end plugs to seal closure as required.
    - j. Furnish and install re-enterable encapsulant and buffers as recommended by the manufacturer.
    - k. The ground/bond kits, and washers shall all be by the same manufacturer.
- B. Copper Splice System
  1. Acceptable Manufacturer: 3M 710 Series Modules, or approved equal.
    - a. Straight splice and half-tap as required by application.
    - b. 25-pair splice modules.
    - c. Filled splices for outside plant splice applications.
    - d. Dry splices for inside plant splice applications.
    - e. Furnish and install quantity of splice modules as required to splice all cables furnished and installed as part of this project and existing cables to be spliced.

## 2.7 IDF CABINET

- A. Acceptable Manufacturer: Middle Atlantic VMRK-5436 54U: 24"W X 42"D X 84"H
1. Complete with Middle Atlantic VMRK-Z4 Seismic Brackets anchored per manufacturer.
  2. Black
  3. Plexi-glass Locking door
  4. Solid side with venting at top and bottom, with the ability to lock the side
  5. Ground buss mounted and bonded in cabinet
  6. Universal hole pattern on the front and rear flanges, and threaded mounting holes on both sides of rack assembly for management
  7. Provide 100 spare screws.
  8. Horizontal cable support bar on rear of each patch panel/cross connect block panel to support hook and loop (Velcro) strain reliefs. Cables will not rely on terminations for cable support.
  9. Hook and loop (Velcro) cable strain relief system on rear of rack to support horizontal and backbone cables. Tie-wraps are specifically prohibited.
  10. Hook and loop (Velcro) horizontal and vertical cable management on front of rack for dressing patch cable and cross connect wiring. Tie-wraps are specifically prohibited.
  11. Hook and loop (Velcro) cable management system independent of cable management to properly dress the electronic equipment power cords through the rack maintaining as much clearances between the two as possible. Tie-wraps are specifically prohibited.
  12. Bonding and grounding cables for all equipment not directly bolted to equipment rack (i.e. shelf mounted electronic equipment, etc.).
  13. Surge protected power strip as described in this specification.
  14. All hardware, supplementary steel, channel and supports as required properly assembling the rack and supporting it to the building structure.
  15. All equipment racks and their hardware will match in appearance and will be provided by a single manufacturer.
    - a. Furnish and install vertical wire management channels on both sides of racks.
    - b. Furnish and install ground terminal block/lug for each rack and #6 ground wire to room ground bus bar.
  16. Telecommunication infrastructure will be completely concealed in lockable telecommunication cabinets. This is typically only specified in semi-permanent spaces, not permanent Telecommunication Rooms.
  17. Floor-mounted cabinets are required. These cabinets will be Self-standing structures.
  18. Equipped with circulation fan.
  19. Equipped with manufacturer provided seismic kit, rated for Zone 4 (Zone 4 seismic installation rated).
  20. Contain internal adjustable rails upon which patch panels, wire managers and network equipment shall be installed.
  21. Contain knockouts for fans and cable routing. Any knockouts used for cable routing will be wrapped with bushings to prevent the rough edges of the knockout from damaging the cabling.

## 2.8 VERTICAL CABLE MANAGERS

- A. Acceptable Manufacturer: Cable Rings compatible with Middle Atlantic cabinet
1. All equipment racks and their hardware shall match in appearance and shall be provided by a single manufacturer.

## 2.9 BRAIDED CLABLE SLEEVES

- A. Provide braided cable sleeves for cabling in rooms.
- B. Polyester expandable sleeving: Flame-retardant and halogen-free.
- C. Manufacturer:
  - 1. Dell City
  - 2. JDD Tech
  - 3. Approved alternate

## 2.10 FLOOR PLAN MAPS WITH NUMBERED WORK AREA OUTLETS

- A. Provide a full size plan of floor plan in each telecom room with numbering associated with each work area outlet for that floor or area and mount on TR wall(s).

## 2.11 PLYWOOD BACKBOARDS

- A.  $\frac{3}{4}$ " grade AC fire retardant plywood required.

## 2.12 BUILDING ENTRANCE PROTECTION

- A. For each copper OSP cable that extends beyond the drip line of the building, a single cable entrance protector is required at each end.
- B. In the Planetarium, the copper OSP will terminate on a small wall-mount CFCI Porta Systems BET. This BET will be mounted inside the IDF Cabinet.
- C. In the new Telecom building the copper OSP will be spliced onto the tail of an existing XLBET protector. Contractor is required to providing all splicing materials. Protectors: 100-pair as required by application.
  - 1. All pairs of the copper backbone cable shall be protected.
  - 2. The protector blocks will be housed within a covered case.
  - 3. Protectors will be sized for the termination of all pairs in the copper backbone cable.
  - 4. The protector blocks shall be fully populated with solid state or gas-tube protection fuses on all pairs.
  - 5. The protector blocks will contain an integrated 110-block for extension to the building cross-connect blocks, or patch panels as determined for each building.
  - 6. The protection block shall have an integrated 26 AWG stub.
  - 7. The protection blocks shall be grounded with a #6 AWG copper bonding conductor between the protector ground lug and Telecommunications Grounding Busbar.
  - 8. Copper extension cables shall be installed from the protector blocks to the copper patch panels, extending one pairs per jack.
- D. Furnish 5 spares per protector.

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

- A. Contact Owner's IT a minimum of one week prior to installation of Entrance Facility hardware and equipment for any instructions they may have for this facility.

- B. Install underground or aerial pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

### 3.2 UNDERGROUND ENTRANCE PATHWAY

- A. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Comply with NECA 1.
- C. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. All equipment in racks must follow the general guidelines provided below in regards to placement within the rack or cabinet.

### 3.3 FIBER OPTIC PATCH PANELS

- A. All fiber patch panels shall be placed at the highest point possible in the rack or cabinet. Fiber patch panels will have integrated cable management in the front and cable guides in the rear.

### 3.4 COPPER PATCH PANELS

- A. All copper patch panels will be installed below the fiber patch panels. The copper patch panels shall be divided according to the following station cabling:
  - 1. Voice patch panels: contains all voice V1 and V2 jacks
  - 2. Data "D1" patch panels: contains all data D1 jacks from every outlet
  - 3. Data "D2" patch panels: contains all data D2 jacks from every outlet

### 3.5 PLACEMENT OF THE COPPER PATCH PANELS ON THE RACKS SHALL BE INDIVIDUALLY DESIGNED FOR EACH TELECOMMUNICATIONS ROOM. IN ALL DRAWINGS, THE CONTRACTOR SHALL BE INSTRUCTED TO "VERIFY PATCH PANEL LAYOUT WITH WVMCCD BEFORE INSTALLATION".

### 3.6 EQUIPMENT CABINETS

- A. CONFIRM PATCH PANEL, CABLE TERMINATION, AND OTHER EQUIPMENT IN CABINET WITH WVMCCD IS department prior to installation.
- B. Securely mount equipment cabinet and racks to the building structure.
  - 1. Proper quantities and supports such as 3/8" lag screws and expansion anchors will be used.
  - 2. Drywall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.
- C. Equipment cabinet mounted on or against walls will have 3-foot clearance in front of deepest component.
- D. Patch Panels: Mount patch panels into the cabinet/rack in top-to-bottom fashion with the first patch panel (Fiber) mounted at the top. Uniquely label each patch panel according to the

numbering convention outlined in the SECTION on labeling. Each port will also have color-coded identifiers. Refer to details on the Drawings.

- E. Cable Management: Secure the cable bundle(s) to the rack strain relief and cable management behind the patch panels and cross connect block panels. Install horizontal cable management panels and brackets for routing and management of patch cables. Maintain TIA/EIA and BICSI standards on bundling, supporting and bend radii.

### 3.7 SERVICE SLACK LOOPS

- A. Service loops are required for all fiber runs so that they can be relocated or spliced, if necessary.
  - 1. Provide a 20-25 foot service loop at each end of an inter-building fiber cable.
  - 2. Fiber cable slack can be coiled and mounted to backboard, or on underside of ladder if it does not affect other cabling.
  - 3. Provide 15 feet of service loop for riser cabling at both ends.

### 3.8 CABLE ROUTING TO AND FROM LADDER

- A. Neatly dress and manage cable transitions from the ladder with hook-and-loop fasteners.
  - 1. Max Loading Depth:
    - a. 24 cable bundles attached to cable runway, with ½” spacing between bundles.
    - b. Furnish and install vertical cable retaining posts on both sides of all cable drop outs, Confirm appropriate ladder sizing with owner representative for horizontal cabling, backbone cabling, and any rack-to-rack cabling installed by owner, prior to ordering and installing ladder.
      - 1) Increase ladder width if filled with greater than 3” deep cable bundles.
      - 2) Route cable bundles off the ladder such that cables on the ‘bottom’ are not crushed or kinked regardless of bundle sizes.
        - a) Utilize hook-and-loop fasteners on bundles *and* vertical posts to manage the horizontal to vertical transition regardless of bundle sizes if required to maintain cable integrity (no kinks or crushed cables).
- B. Where the distance of cabling entering the room to horizontal cable runway exceeds 18”, provide cable support in the form of vertical cable runway that is affixed to wall and to horizontal runway. Where space permits, install cable runway bend radius to effect this transition. Affix cable bundles to runway with hook & loop fasteners.
- C. All cabinets shall be mounted with a minimum of 3 feet clear access in front, back and sides of cabinets. All cabinets shall be properly anchored to the slab floor using manufacturer-provided seismic bracing kit. Per DSA approved design, the anchoring will use Hilti ½” anchor bolts which pass a 45 lb. torque test. Refer to structural for other requirements.
- D. The cables are to be as accessible as possible.
- E. Pull conductors together where more than one is being installed in a raceway.
- F. Cable bundles in suspension systems, or on wallboards must be velcro-wrapped every 4 feet. Strapping to any other wires (e.g. lighting ceiling grid, etc.) will not be permitted. Station wire cannot be attached to electrical conduit, gas or sprinkler piping, or other code-restricted items.
- G. Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate cable sheath or conduit.

- H. No cabling is allowed to rest on any ceiling tile or suspension system.
- I. Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.
- J. Cables shall not be pulled across sharp edges. Bushings will be installed on rough sleeve or conduit edges before cable installation takes place. Cables shall not be forced or jammed between metal parts, assemblies, etc.
- K. Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.
- L. Insulation shall be removed to expose shielding and conductors to the exact length required by manufacturer for proper termination of plugs and pins and as specified in TIA 568/569.
- M. Pins and plugs, upon termination, shall not be damaged in any way.
- N. Cable guides and suspensions (J-hooks, cable runway, waterfalls, etc.) shall be provided to ensure that the cable path is securely suspended and adheres to the manufacturer's bend radius.
- O. Cable splicing will not be permitted at any point within a cable run.
- P. Cable mountings on backboards will be installed efficiently (no divers), to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be velcro-wrapped every 4 feet and routed through a support structure for a neat appearance and manageability. Wall support structures will be designed and can include a wall-mounted section of cable tray, ladder rack or metallic raceway.
- Q. Per grounding described above, cabinets will be grounded to the TGB with a minimum #6 AWG copper wire.

### 3.9 BONDING AND GROUNDING

- A. Refer to Section 27 05 26 for Bonding & Grounding requirements.
- B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Protection".
- C. Comply with ANSI-J-STD-607-B.
- D. Locate grounding bus bar to minimize the length of bonding conductors.
- E. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar.
- F. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- G. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
- H. Retain subparagraph below if screened twisted-pair cables and coaxial cables are in communications equipment rooms.



1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

### 3.10 ANTI STATIC – WALLS & FLOORS

- A. Seal walls and concrete floors and finish to be anti-static.

### 3.11 BRAIDED CLABLE SLEEVES

- A. Provide expandable braided cable sleeves for routing cable bundles from point of entry to racks and cabinets.
- B. Clarify with Owner if color coding of sleeving is required for different device types.

### 3.12 SEISMIC CONSIDERATIONS

- A. Contractor is responsible to install a fully functional UL Listed system, which when complete, shall be rated for the seismic zone in which it is installed.
- B. Install all bracing, straps, bolts, etc. to effect this requirement regardless of T series drawings depictions.
- C. Installations or field modifications to installation designs shall be coordinated with a structural engineer.
  1. Provide shop drawings that conform to structural engineer's approved attachment and loading requirements.
  2. With respect modifications required due to field conditions, coordinate with and receive approval from a licensed structural engineer.
  3. Submit for inclusion in the Project Manual structural engineer's approved methods and attachment and loading requirements.

### 3.13 FLOOR PLAN MAPS WITH NUMBERED WORK AREA OUTLETS

- A. Place floor plan sheet behind a removable protective covering (E.G.: Plexiglas) and mount on TR wall(s).
- B. Floor plan shall show accurate as-builts of outlet locations and numbering. Do not include contractor logo.

### 3.14 BACKING

- A. Plywood must be securely fastened to wall framing members to ensure that it can support attached equipment.
  1. Affix plywood to all studs a minimum of every 18" with screws that penetrate a minimum of 1" into studs.
  2. Screws must be flush with plywood. Countersink if required to meet this requirement.
  3. Wall linings will extend from 2' AFF to 10' AFF, with cutouts at electrical outlet locations.
  4. These cutouts shall be no larger than the electrical outlet itself.
- B. Flush hardware and supports must be used to mount the plywood.
- C. Install with the A grade surface exposed.

1. Coordinate with Owner and fire marshal to determine if fire rating must be exposed, or if bill of lading can be presented to validate fire rating of plywood. If this is allowed, place smooth side of plywood to room interior.

END OF SECTION

## SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section governs the products and execution requirements relating to furnishing and installing backbone cabling for the communication systems, and supplements requirements found in related sections.
- B. Related Sections:
  - 1. 270000: Communications
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270536: Communication Cable Pathways
  - 4. 270810: Optical Fiber Testing and Measurement
  - 5. 270820: Copper Testing
  - 6. 271100: Communications Equipment Room Fittings
  - 7. 271500: Communications Horizontal Cabling
  - 8. 271600: Communications Connecting Cords Devices & Adapters

#### 1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- A. All conduit and EMT required for Communications cabling pathway in/out of cross connect closets and in/out of wall cavities at the work area. EMT or Conduit for pathways shall have no more than two 90-degree bends and no continuous section over 100'.

#### 1.3 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system will provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

#### 1.4 WORK INCLUDED

- A. The Work of this Section shall consist of the labor, materials and equipment required for installing and/or furnishing backbone cabling as part of a complete and operating telecommunications cabling system.
- B. All items specified or included in this section shall be furnished and installed by Telecommunications Contractor, wired and connected by Telecommunications Contractor and tested by Telecommunications Contractor, unless noted otherwise. "Contractor" as used herein shall mean Telecommunications Contractor or Telecommunications Contractor's sub-contractor.

#### 1.5 SUBMITTALS

- A. Submit for approval in accordance with specified submittal procedures.
- B. Prepare submittals for all components of the telecommunications system, as specified herein.

## 1.6 COORDINATION

- A. Contractor shall furnish and install as required:
  - 1. Inside plant copper backbone cables.
  - 2. Inside plant fiber optic backbone cables.
  - 3. Outside plant copper backbone cables
  - 4. Outside plant fiber optic backbone cables
  
- B. Electrical Contractor shall furnish and install the following:
  - 1. Telecommunications raceways within the building.
  - 2. Telecommunications duct banks, hand-holes and manholes.

## PART 2 - PRODUCTS

### 2.1 FIBER OPTIC CABLES

- A. Acceptable Manufacturer: CommScope Systimax TeraSPEED or approved equal.
  - 1. Verify raceway fill requirements when furnishing and installing two standard cable constructions to meet composite strand count requirements.
  - 2. Fiber Cable - Outside Plant
    - a. Cable Construction:
      - 1) Loose tube, up to 12 fibers per tube.
      - 2) Dry water-blocking tape.
      - 3) Fillers as required by strand count and cable construction.
      - 4) Epoxy glass central strength member.
      - 5) Reverse oscillation stranded buffer tubes.
    - b. Jacket Material: Medium density polyethylene
    - c. Fiber Count: As indicated on Drawings (singlemode/multimode).
    - d. Fiber Type:
      - 1) Single-mode: 8.2/125.
  - 3. Optical Fiber Performance Requirements OSP Glass Transmission Media - Single Mode
    - a. Acceptable Manufacturer: CommScope Systimax TeraSPEED approved equal.
  - 4. TeraSPEED zero water peak singlemode (ZWP-SM) fiber designed to operate over the entire wavelength range — from 1280 nm to 1625 nm.
  - 5. 100+ Gb/s full-spectrum singlemode fiber solution with added bandwidth capacity in the E-band
  - 6. ITU-T G.652.C compliant
  - 7. Fiber Optic Cable Shipping Requirements
    - a. All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
    - b. Top and bottom ends of the cable shall be available for testing on the shipping reel.
    - c. Both ends of the cable shall be sealed to prevent the ingress of moisture.
    - d. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:
      - 1) Cable Number, Gross Weight
      - 2) Shipped Cable Length in Meters, Job Order Number
      - 3) Manufacturer Product Number, Customer Order Number
      - 4) Date Cable was Tested, Manufacturer Order Number
      - 5) Cable Length Markings, Item Number
        - a) Top (inside end of cable)
        - b) Bottom (outside end of cable)
    - e. Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:

- 1) Manufacturer Cable Number, Manufacturer Product Number
  - 2) Manufacturer Factory Order Number, Customer Name
  - 3) Customer Purchase Order Number
  - 4) Mark for Information Ordered Length
  - 5) Maximum Billable Length, Actual Shipped Length
  - 6) Measured Attenuation of Each Fiber Bandwidth Specification (for lengths > 1000 m)
- B. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification. Multi-pair Cable - Inside Plant,
- C. Shipping Requirements
1. All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
  2. Top and bottom ends of the cable shall be available for testing on the shipping reel.
  3. Both ends of the cable shall be sealed to prevent the ingress of moisture.
  4. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:
    - a. Cable Number, Gross Weight
    - b. Shipped Cable Length in Meters, Job Order Number
    - c. Manufacturer Product Number, Customer Order Number
    - d. Date Cable was Tested, Manufacturer Order Number
    - e. Cable Length Markings, Item Number
      - 1) Top (inside end of cable)
      - 2) Bottom (outside end of cable)
- D. Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:
1. Manufacturer Cable Number, Manufacturer Product Number
  2. Manufacturer Factory Order Number, Customer Name
  3. Customer Purchase Order Number
  4. Mark for Information Ordered Length
  5. Maximum Billable Length, Actual Shipped Length
  6. Measured Attenuation of Each Fiber Bandwidth Specification (for lengths > 1000 m)
- E. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

## 2.2 CATEGORY 5

- A. 25 Pair OSP Category 5 Filled Copper Cable
1. Acceptable Manufacturer: Systimax/Commscope, Superior Essex, or approved equal.
  2. Cable Type: OSP filled MEGAPIC Broadband Category 5 filled cable.
  3. Jacket Material: Polyethylene.
  4. Sheath Material: 8-mil aluminum tape.
  5. Jacket Markings: Manufacturer's identification, pair count, wire AWG, sequential footage.
  6. Conductors: Solid 24 AWG copper.
  7. Twisted pairs with varying lay lengths, quantity of pairs as indicated on Drawings.
  8. Conductor Insulation: Polyolefin.
  9. Industry standard color coding, with colored binder tape for cable sizes greater than 25-pair.
  10. Electrical Characteristics: Meets TIA/EIA-568B requirements for Category 5 cables.
  11. OSP rated cable suitable for installation in underground conduit.

2.3 COPPER PROTECTORS

1. Refer to 27 11 00

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. All cable and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All cable and associated hardware shall be placed so as to not impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).
2. Where cable is placed in ceiling areas or other non-exposed areas, cables shall be installed in cable trays or in non-continuous cable support system. Non-continuous cable supports shall be placed at random intervals no greater than 48 inches. Cables in non-continuous support systems shall be bundled using hook and loop type fasteners. Cable sag between supports shall not exceed 3 inches. Attaching wire to pipes or other mechanical items is not permitted. Cables shall not be bundled or tied in conduits, and in cable trays above ceilings.
3. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, network equipment, mechanical equipment access doors and covers, switches or electrical panels, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser at a later time by maintaining a working distance from these openings. All cable shall be installed to allow for simple installation and removal of cables in the future.
4. Unless noted, all interior wiring shall be installed in raceways. Wiring above accessible ceilings may be installed in cable tray and exposed on "J" hooks.
5. All cables not in raceways shall be riser or plenum rated.
6. All cables running outside the building shall be rated for outside plant installation.
7. Backbone cables shall be grouped separately from horizontal distribution cables. Cable for other systems shall be grouped separately from cables for telephone and data.
8. All inside cable shall be installed neatly above accessible ceilings using cable tray and "J" hooks supported from building structure. Do not attach to pipes, conduits, ducts, etc. Do not allow cable to rest on pipes, conduits, ducts, ceiling tiles, etc. Do not attach to wires used for supporting suspended ceilings. Do not use tie wires or bridle rings.
9. All wires shall be marked at all junction boxes, pull boxes, cabinets, boxes and terminations. Each cable run between terminating locations shall be one continuous cable (no splices or connections).
10. The Contractor shall install cable in such a manner as to prevent stretching, kinking or sharp bends. Cable damaged during installation or not passing required testing shall be removed and replaced at no additional cost to Owner.
11. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, loosely twisted and over twisted pairs at terminations, and too much jacket removed.
12. Minimum bend radius and maximum pulling tension for all cables shall be maintained during and after installation. Install cable in accordance with manufacturer's ratings and instructions.
13. Cables shall not be installed near power sources or other items where interference could develop. Cables shall not be placed within 18 inches of light fixtures and within 3 feet of motors, transformers, copy machines, or solid state motor starters unless cable is installed in conduit. Contractor shall furnish and install a grounding conduit system where these minimum clearances cannot be maintained.

14. In telecommunications spaces, cables shall be routed as close as possible to the ceiling, floor, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed.
  15. Dress and attach cables to the backboard along the shortest possible route run square (horizontal and vertical) to the backboard. Bundle similarly routed cables together and attach by means of clamps or distribution rings. Cable dress and attachment shall minimize obstruction to future installations of equipment, backboard, or other cables.
  16. Cables shall be neatly bundled with hook and loop type fasteners. Nylon tie wraps are not acceptable. Cables must be neatly bundled in the telecommunications spaces and at the cable service loop.
  17. Cable service loops shall be provided at both ends of backbone cable runs.
    - a. At the telecommunications room, provide a minimum 8 foot service loop stored in a figure eight pattern in the cable tray above the racks/cabinets.
    - b. At the telecommunications room, provide sufficient slack to properly dress and terminate cables at the racks and cabinets.
      - 1) Provide sufficient slack so that swing gate type racks and cabinets can open fully
      - 2) Provide sufficient slack so that cables do not catch or bind at swing gate type rack or cabinet hinge and the cables do not pull taught across the hinge or edge.
      - 3) A minimum 25 foot service loop shall be maintained at each building entrance and exit.
        - a) A minimum 25 foot service loop shall be maintained at each building entrance and exit.
  18. All interior fiber optic cables shall be installed in plenum rated inner duct above accessible ceilings.
    - a. Inner duct shall be installed to within 12 inches of termination enclosure.
    - b. Install pull boxes, 12" x 12" minimum, as required to limit cable pulls to two 90 degree bends or 150 feet.
    - c. Inner duct shall not be kinked or tightly bent in any way.
    - d. All exterior fiber optic cables shall be installed in inner duct.
  19. A break-away link shall be used for installation of cables with a cable-puller or winch. The break-away link shall be designed to separate at or below the recommended maximum tension of the cable being installed.
  20. Any damage to Owner's existing cabling or existing cable owned by others, caused as a result of work performed under this scope, shall be brought to the Owner's attention and repaired or replaced within 48 hours.
  21. Contractor shall use only cable lubricants recommended by the manufacturer for use with the specific cable construction.
  22. Should a cable become kinked, skinned or stretched during installation, the cable shall be removed and replaced at no additional cost to the Owner. Splicing at points other than those specified will not be acceptable.
- B. Outside Plant Cable
1. Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate cable or conduit. Adhere to all manufacturers' requirements regarding pulling tension and allowable lubricants.
  2. All cable/cabling shall be kept 30 inches away from any heat source; i.e., steam valves, etc.
  3. Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.

4. Cables shall not be pulled across sharp edges. All conduits and sleeve with rough edges will be provided with bushings on both ends. Cables shall not be forced or jammed between metal parts, assemblies, etc.
5. Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.
6. Cable splicing will not be permitted at any point within a cable run.
7. All outside plant backbone cables will be installed in conduit.
8. Aerial and direct burial runs are not permitted.
9. Conduits will not be filled to greater than a 40% fill.
10. Conduits must have appropriately size pull-boxes every 500 feet. When the conduit routes through up to a total of two 90 degree bends (180 degrees total) in any dimensional plane, pull-boxes are also required. Outside Plant Conduits shall conform to the additional design guidelines detailed in Section 6 of this document. Cabling will not be installed in conduits that do not meet these specifications.
11. Backbone cables will be installed with a 30 foot service loop. At each building, the service loops will be coiled neatly in the pull box or nearest hand hole to the building. Cable mountings and service loops on backboards will be installed efficiently to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be tie-wrapped every 4 to 6 feet.
12. Cable shall be continuous and without splices.
13. All actual cable distances will be verified.
14. All outside plant cables will be terminated within 50 feet of the entrance point. This is a maximum measurement and includes lengths for service loops, routing, backboard support and patch panel mounting inside the building.
15. Copper service loops will be provided around the periphery of the backboard, securely mounted to D-rings or other cable management apparatus.

C. Copper Protection

1. All copper backbone cables that extend between buildings will be terminated at both ends on protector blocks and be extended from the protectors and terminated on rack-mounted patch panels, **one pair per RJ-45 jack**.
1. This will facilitate moves and changes via patch cords from the station jack instead of cross-connect wire. For backbone cables, this means cables will be extended OSP cabling shall splice onto fuse terminals tails.
2. All splicing apparatus, including splice case, splice modules, grounding, etc., is included in the project.
3. In the MPOE, if insufficient fuse terminals are available, the project shall add panels, in rows of 300 pairs, fully populated with fuses, regardless of the pair count needed for that specific building project.
4. In the buildings:
  - a. Protected all pairs of the copper backbone cable.
  - b. The protector blocks will be housed within a covered case.
  - c. Protectors will be sized for the termination of all pairs in the copper backbone cable.
  - d. The protector blocks shall be fully populated with solid state or gas-tube protection fuses on all pairs.
  - e. The protector blocks will contain an integrated 110 block for extension to the building cross-connect blocks, or patch panels as determined for each building.
  - f. The protection block shall have an integrated 26 AWG stub.
  - g. The protection blocks shall be grounded with a #6 AWG copper bonding conductor between the protector ground lug and Telecommunications Grounding Busbar.
  - h. Copper extension cables shall be installed from the protector blocks to the copper patch panels, extending one pairs per jack. (See section 7.6 in Campus Network Infrastructure Cabling Standards).



### 3.2 FIBER PATCH PANELS/SHELVES

- A. Rack mounted (for data).
- B. Duplex SC style termination configurations.
- C. Completely covered.
- D. 4U high-density shelf for Main and Building Telecommunication Room installations, or 24-connector 2U sliding trays for smaller Telecommunication room backbone terminations where fiber counts are less than 24 fibers.
- E. For Fire Alarm and AV fiber, the fiber patch panels will be wall-mount and placed above the Fire Alarm panel or in the equipment room.
  - 1. Confirm locations with Campus prior to installation.
- F. Locations will be coordinated during the design phase.
- G. 7.5.2 Optical Fiber Connectors – Data Field termination is required for all fiber strands in the telecommunications closets.
- H. All connectors are to be glass-in-ceramic SC-compatible duplex connectors with caps to prevent contamination.
  - 1. SC connectors shall meet TIA-568C standards.
- I. Connectors must have a locking feature to the coupler to prevent optical disconnect.
- J. Adhere to all manufacturer installation guidelines.
- K. Single mode duplex connectors shall be blue.
- L. The maximum insertion loss per each mated field installed connector pair shall not exceed 0.75 dB.
- M. The total optical attenuation through the cross-connect from any terminated optical fiber to any other terminated fiber shall not exceed 1.5 dB.
- N. Single mode fiber shall have a return loss greater than or equal to 26 dB.
- O. The connectors shall sustain a minimum of 500 mating cycles without degrading this performance.
- P. Note: For AV and Fire Alarm backbone connections, the cabling will terminate on LC connectors.
- Q. The connector ends, length and quantity of fiber patch cords will be determined in the design phase. Duplex patch cords for all fiber strands pulled are required, and will be included in the project scope.

### 3.3 FIBER LOSS BUDGET

- A. Total maximum loss budget for a 40 or 100 GbE link is 1.9 dB.
  - 1. Re-do connections to achieve this budget.

3.4 MULTI-PAIR AND FIBER CABLES

1. In the Planetarium, the copper OSP will terminate on a small wall-mount CFCI Porta Systems BET. This BET will be mounted inside the IDF Cabinet.
2. In the new Telecom building the copper OSP will be spliced onto the tail of an existing XLBET protector. Contractor is required to providing all splicing materials.

3.5 CONDUITS AND CABLING

- A. Coordinate with electrical contractor to provide conduit pathways for cabling that would otherwise be 'buried' in walls or above ceilings.
- B. All cabling must be permanently accessible, either directly, or via conduits.

END OF SECTION

## SECTION 27 1500 - COMMUNICATIONS HORIZONTAL CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section includes information on horizontal communications cabling supplementing requirements found in the related sections.
- B. Related Sections
  - 1. 270000: Communications
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270536: Communication Cable Pathways
  - 4. 270810: Optical Fiber Testing and Measurement
  - 5. 270820: Copper Testing
  - 6. 271100: Communications Equipment Room Fittings
  - 7. 271300: Communications Backbone Cabling
  - 8. 271600: Communications Connecting Cords Devices & Adapters

#### 1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- A. Conduit and EMT required for Communications cabling pathway in/out of cross connect closets and in/out of wall cavities at the work area where ceiling is inaccessible.
- B. Rings (and strings) with conduit connecting tabs for the mounting of NEMA rated faceplates where required.
- C. Drag line or pull string at the ring fished through EMT or conduit to the other end for installing 4 pair and multi-pair cables.

#### 1.3 SYSTEMS DESCRIPTION

- A. Horizontal copper cabling system consists of CommScope Systimax Category 6A rated cables with four unshielded twisted pairs of solid annealed copper wrapped in plenum rated insulation with an overall plenum rated jacket with a wire thickness of 23 AWG. Each four pair cable is terminated onto 8 position 8 conductor rated connectors using 110 style IDCs. Connectors are placed into NEMA rated faceplates at the work area and placed into rack mounted patching panels in the equipment / networking rooms.
- B. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
  - 1. TIA-568-C.0 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
  - 2. Horizontal cabling will contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
  - 3. Bridged taps and splices will not be installed in the horizontal cabling.
    - a. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
    - b. The maximum allowable horizontal cable length is 250 feet. This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 18 feet in the horizontal cross-connect.

#### 1.4 MANUFACTURER QUALIFICATIONS

- A. Manufacturer shall be CommScope Systemax.
- B. Manufacturer shall be ISO 9001 certified manufacturer and shall employ Six Sigma methodology in its manufacturing process.

#### 1.5 TESTING AGENCY QUALIFICATIONS

- A. Independent testing agencies shall be nationally recognized as having the expertise to independently verify copper and optical fiber cabling systems and components.
- B. Testing Agency Qualifications: Must be a NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.
- E. Grounding: Comply with ANSI-J-STD-607-B.

#### 1.6 WARRANTY

- A. Contractor shall provide a 1 year parts and labor warranty against defective workmanship and/or system component failure.
- B. Contractor shall execute CommScope Enterprise 20-year Extended product warranty and Application Assurance.
- C. As further described below, the "Supplier" shall warrant to the customer ("Buyer") that the CAT 6A certified network installations will exceed the defined TIA 568 series industry specifications in force at the time of product purchase. Furthermore, the products that comprise the certified Cabling System will meet or exceed the applicable product performance specifications in effect at the time of manufacture.
- D. This warranty covers the copper and fiber optic permanent links of the network as defined by TIA-568-C.0 which includes the cable and connecting hardware. This warranty will be extended to include the entire channel provided that the applicable patch cords and equipment cords are utilized, and all products are installed within areas protected from outside elements.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. The Electrical Code referred to in these specifications is the National Electrical Code as currently adopted by the State of CA. All work will be provided in strict compliance with the Electrical Code and all regulations that may apply.

- B. Where standards exist, for a particular category, products used on this project will be listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL), and be approved or listed for the intended service and application.
- C. These specifications do not undertake to repeat the requirements of codes, regulations or NRTL listing or labeling instructions. The Specifications or Drawings may require items or work beyond the requirements of applicable codes or regulations. The stricter, higher quality, greater quantity or higher cost will be provided. It is incumbent on the Installer, material and equipment suppliers to meet these specifications, applicable codes, regulations, and NRTL listing agency restrictions.

## 2.2 MANUFACTURER

- A. The word "Manufacturer" will include the Manufacturer, the Manufacturer's Representative, the Distributor, the Fabricator, and the Supplier of the particular classification of equipment, system, product, and material.
- B. All work, equipment, and systems will be manufactured, provided, repaired, installed, and tested in accordance with the latest edition and all current amendments of the applicable publications and standards of the organizations listed below as of the date of the Contract Documents. When the Specification requirements exceed the requirements of these publications and standards the Specifications will govern:
  - 1. State Building Code (SBC)
  - 2. Building Department Inspectional Services
  - 3. American Society for Testing and Materials (ASTM)
  - 4. Underwriter's Laboratories, Inc. (UL)
  - 5. Insulated Cable Engineers Association (ICEA)
  - 6. National Electrical Manufacturers Association (NEMA)
  - 7. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
  - 8. American National Standards Institute, Inc. (ANSI)
  - 9. National Fire Protection Association (NFPA)
  - 10. Local Electric Code
  - 11. Department of Public Safety (DPS)
  - 12. Building Officials and Code Administrators International, Inc. (BOCA)
  - 13. Department of Labor USA. Safety and Health Regulations for Construction (OSHA)
  - 14. Energy Codes
  - 15. National Electrical Contractors Association (NECA)
  - 16. National Bureau of Standards (NBS)
  - 17. Federal Communications Commission (FCC)
  - 18. Utilities Serving Project.
  - 19. Fire Department.
  - 20. Americans with Disabilities Act Applications Guidelines (ADAAG).
  - 21. Accessibility Guidelines for Buildings and Facilities.
  - 22. Any and all Federal, State and Local Standards, Codes and Authorities having Jurisdiction.
  - 23. In addition, all phases of the Structured Cabling System installation will adhere to applicable Local Area Network (LAN) Specifications of the Institute of Electrical and Electronics Engineers (IEEE), Electronics Industry Association/Telecommunications Industry Association (TIA/EIA), and Building Industry Consulting Service International (BICSI). The entire system and all components will be NRTL certified to appropriate TIA/EIA performance rating Category, Latest TIA/EIA Standards 455-A, 492AAAA, 568-A (latest revision) and (SP-4195-B and SP-4195-B-1), 569-A, 570, 606, 607 and 758, TIA/EIA TSB 67, TSB 72, TSB 75, TSB 95 and other standards as applicable.

- C. The Installer will have available at the job site at all times one copy of the latest edition of the Electrical Code, TIA and BICSI Standards applicable to the work as specified within this document.
- D. The above requirements will not in any way limit responsibility or requirements to comply with all other codes, standards and laws.
- E. Material, equipment, enclosures, and systems will be designed for use as required to suit the conditions, exterior or interior operation, dust tight, water tight, explosion-proof, or other special types.

### 2.3 UTP PIN/PAIR TERMINATION ASSIGNMENT

- A. The UTP cabling systems will have TIA/EIA T568B pin/pair termination assignment. All conductors provided will be properly and consistently terminated at both ends throughout the entire systems. Maintain proper untwist of pairs and removal of jacket per TIA and BICSI.

### 2.4 SYSTEM PERFORMANCE

- A. Horizontal four pair Category 6A copper cabling system shall be capable of supporting 1G Base-T and 10G Base-T applications respectively for a total distance of 100 meters with equipment cords.
- B. System shall provide "future proof" channel performance and guaranteed margins as noted in this document and is guaranteed to exceed ANSI/TIA/EIA-568-C Category specifications for Insertion Loss, NEXT, PSNEXT, ACR, PSACR, ELFEXT, PSELFEXT, AXT, and Return Losses to 500 MHz for Category 6A. The system is also guaranteed 6Db PSACR headroom 500 MHz for 6A cabling.

### 2.5 SOURCE QUALITY CONTROL

- A. All materials shall be purchased from Distributors authorized by system Manufacturers to sell new and unused components.

### 2.6 COPPER CATEGORY 6A PATCH PANELS

- A. EIA/TIA Category 6A standard.
- B. Rack mounted with front-facing RJ-45 patch panels and using rear-facing snap-in termination managers for cable installation.
- C. Angled design to facilitate patch cord access.
- D. Will be T568-B wired.
- E. UL listed.
- F. Have a paired punch down sequence to allow pair-twist within ½-inch of the termination. Equipped with Cable Termination Manager modules to ensure minimized untwisting of station cabling during installation.
- G. Made of rolled edge black anodized aluminum construction.
- H. Must have 48 ports with rear cable suspension racks.

- I. Must be from the same manufacturer as the other connectivity products (cable, jacks, faceplates, etc.).
- J. Rear patch panel cable management will include the cable support bars/troughs.

## 2.7 VOICE BACKBONE PATCH PANELS

- A. EIA/TIA Category 5 standard.
- B. Angled jack mounting to facilitate patch cord access.
- C. UL listed.
- D. Voice backbone cables shall be extended from the Protector terminal to rack-mounted patch panels. The patch panels shall conform to the following specifications:
- E. Rack mounted with front-facing RJ-45 patch panels and rear-facing 110 blocks.
- F. Have a paired punch down sequence to allow pair-twist within ½-inch of the termination.
- G. Made of rolled edge black anodized aluminum construction.
- H. Must have 48 ports with rear cable suspension racks.
- I. Must be from the same manufacturer as the other connectivity products (cable, jacks, faceplates, etc.).

## 2.8 WALLPLATES

- A. Manufacturer - Systimax 2 to 4 ports where required.
- B. The standard faceplate configuration is single-gang faceplate providing for four ports of connectivity. Configurations of any additional number of ports are subject to the approval of WVMCCD District IS.
- C. The faceplate housing the jacks shall provide a symmetrically centered appearance for the modules.
- D. Snap-in inserts shall be provided to cover any unused openings in the faceplate. Inserts are removable for future installation of additional jacks.
- E. It shall be possible to install the jacks in wall-mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters.
- F. The faceplate housing the jacks shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
- G. The faceplate housing the jacks shall accommodate up to a maximum of four modules in a single-gang form.
- H. The faceplate housing the jacks shall provide flexibility in present of future network needs such as audio, video, coaxial and optical fiber applications.
- I. The color of the faceplate shall be coordinated with the color of the surrounding electrical outlets, usually as Electric Ivory or Electric White.

- J. No metal faceplates will be allowed, except as required for extra durability at wall-mount telephone locations and external potentially wet locations.
- K. The required product is the Systimax MLE faceplate.

## 2.9 CATEGORY 6A JACKS

- A. Manufacturer – Systimax, or approved equal.
  - 1. Communications Faceplate ports shall contain Category jacks which are matched to cable. Jacks shall be terminated to the Horizontal Cabling and inserted into the Communications Faceplate.
  - 2. Modular jacks shall terminate using 110-style pc board connectors, color-coded for both T568A and T568B wiring. The 110-style insulation displacement connectors shall be capable of terminating 22-24 AWG solid or 24 AWG stranded conductors. The insulation displacement contacts shall be paired with additional space between pairs to improve crosstalk performance. Modular jacks shall utilize a secondary PC board separate from the signal path for crosstalk compensation. Modular jacks shall meet the ANSI/TIA-568-C.2 requirements matching or exceeding the Category performance of the cabling.
- B. Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.
  - 1. The jack shall be a punched down on a 110-IDC connector.
  - 2. The punch down scheme shall be T-568B.
  - 3. The jack shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than the Category 6A pair-to-pair NEXT performance specifications, and shall have a mark to indicate compliance.
  - 4. The jack shall have all of its housing components made of fire retardant UL 94V-0 plastic.
  - 5. The jack shall have a protective cap that snaps in the back of the module to provide strain relief for the conductors after termination.
  - 6. The jack shall have a minimum Insulation Resistance of 500 mega ohms.
  - 7. The jack shall be FCC Part 68, Subpart F compliant.
  - 8. The jack shall be IEC-603-7 compliant.
  - 9. The jack durability shall be greater than 750 mating cycles (cable insertion/removals).
  - 10. The jack maximum Current Rating shall be 1.5 amperes.
  - 11. The jack shall have caps on the front which designate "GS" for voice and "DATA" for data.
  - 12. All jacks will be installed with the color coded caps.
- C. Connection Reliability
  - 1. Use connectors with 50 µm gold-plated tines (as specified by TIA standards), as well as designs that distance the connection point between the connector tines and plug from the arcing damage.
  - 2. Connectors should also meet contact resistance requirements found in the IEC 60512-99-001 standard covering connectors for electronic equipment.

## 2.10 WET LOCATION OUTLETS

- A. Ruggedized Connectivity Solution complete with stainless steel faceplate and protective caps
  - 1. Cap: MIR-CAP
  - 2. Faceplate:
    - a. IR12SP-2 port single gang
    - b. IR24SP-4 port double gang



- B. Approved Manufacturer and #: Systimax, MIR-RJ45

## 2.11 UTP CABLE

1. Manufacturer Systimax
2. Cable jacketing:
  - a. Shall be blue and lead-free for data.
  - b. Security, AV and WiFi locations shall be blue.
  - c. Shall be white and lead-free for voice.
3. Cable shall be supplied [in a reel-in-box or on wooden reels]. Cable shall be independently verified for flammability by UL and listed under file number E138034 and shall comply with NEC article 800, NFPA 70, and [CMP (NFPA 262, UL 910) or CMR (ANSI/UL 1666, IEC 332-1)].
4. Copper clad aluminum cables are not permitted. Installation of such will be cause for the necessity of removing the cabling and the installation of copper cables at the contractor's expense.
  - a. Any costs associated with project delays caused by the installation of these cables and the removal and installation of acceptable cables will be borne by the contractor.

## B. OSP

1. Install outside wet / duct rated cables for horizontal cabling installed in slab-on-grade and exterior applications.
2. Transition to plenum rated cabling where OSP cables must transition to interior spaces when not in conduits to terminus.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to section 27 00 00
- B. All installation shall be done in conformance with ANSI/TIA/EIA-568-C standards, BICSI methods, industry standards and manufacturer's installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. Patch panels will be used for termination of all voice and data station cabling.
- D. Cable is to enter perpendicular to the termination and the cable bar facilitates this requirement.
- E. All cable bundles on cable support bars will be managed with Velcro straps.
  1. Tie-wraps are not acceptable.
- F. Cable socks are suitable for routing, but must be transitioned to Velcro bundles at patch panel terminations.
- G. Cables are NOT to be painted, and are to be routed through solid bottom cable tray or conduits so that they are not visible.

### 3.2 STATION PATCH PANELS

- A. A maximum of five (5) patch panels will be provisioned per relay rack.
- B. Data will be divided into D1 and D2 patch panels (Note: There are no D3, D4 jacks.)
- C. Voice station cables will be terminated onto separate patch panels.
- D. In all drawings, the contractor shall be instructed to "Verify patch panel layout with WVMCCD before installation".
- E. Wired with one pair punched down per jack, 25<sup>th</sup> pair coiled as a test point.
- F. Provide shall provide a 3-foot service loop above the access ceiling or cable trays unless specified otherwise. All service loops shall be a minimum of 18 inches in diameter and be accessible for maintenance.
- G. Coordinate loop placement and orientation with the technology consultant. This allows for future changes or expansion without installing new cables.
- H. Cabling between communications rooms and workstation locations shall be made as individual "home runs". No intermediate punch down blocks or splices may be installed or utilized between the communications rooms and the information outlets at the workstation location.
- I. All cable must be handled with care during installation so as not to change performance specifications. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable. There shall never be more than .5 inches of unsheathed Category 5e or 6 UTP cable at either the wiring closet or the workstation termination locations.
- J. All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair equipment's efficient use of their full capacity.
- K. EMT or Conduit for pathways shall have no more than two 90 degree bends and no continuous section over 100'. Each conduit opening will be fitted with a nylon bushing to prevent damage to cables.
- L. Provide cable J-Hooks to support main pathway cable bundles.
- M. Exposed Cable
  - 1. All station cabling shall be installed inside walls or ceiling spaces whenever possible.
  - 2. Exposed station cable will only be run where indicated on the drawings and will only be allowed when no other options exist. Owner must approve all exceptions.
- N. Coordinate with other trades on whether there is a presence of variable frequency drive motors (VFD) being used above ceilings or at any location in the building, and if so, where their locations are.
  - 1. Route cabling away from VFD motors, maintaining a minimum of 6 feet from the motors.
- O. 110-type blocks
  - a. Unique identifiers
    - 1) Segregation and position on equipment rack
    - 2) Port color-coding

- 3) Unique labeling
  2. The Contractor shall provide a copy of the finalized plan in writing to the Owner's representative for review and authorization to proceed.
- P. All cabling placed above drop ceilings must be supported by cable tray, conduit, or J-Hooks. The Contractor shall permanently affix cable supports to the building structure or substrates and provide attachment hardware and anchors designed for the structure to which attached and are suitably sized to sustain the weight of the cables to be supported. Attaching cable to pipes or other mechanical items is not permitted. Communication cables shall be routed so as to provide a minimum of 18 inches spacing whenever possible from light fixtures, sources of heat and EMI sources. Cabling shall not be attached to ceiling grid wires. Multiple cables are to be dressed every 5 feet to 7 feet. Maximum cable sag between cable hooks is 3"-6".
1. Plastic/nylon tie-wraps are not allowed. (See Section 270529 Hangers and Supports for Communications Systems).
- Q. Maximum allowable temperature rise above ambient temperature is 55 degrees F.
1. Reduce cable bundle sizes and separate bundles to mitigate cable bundle temperature rise to a max of 55 delta from ambient.
  2. Maximum allowable cable bundle internal temperature is 130 degrees F. Provide mitigation if allowable temperatures are exceeded.
- R. In the Telecommunications Room (TR), cables shall be combed and dressed with Velcro ties in a manner as to prevent twists, "braiding" and crossed cables in the cable bundle from the telecommunication room entrance to the termination point at the rear of the patch panel. Behind the patch panel, the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.
- S. Identification:
1. Label cable terminations on designation strips.
  2. Label all cable at each terminating point.
  3. Label each port of the work area outlet.
  4. Cable identification numbers shall not be duplicated.
  5. Labeling convention to be coordinated with Owner.
  6. Label data patch panels and voice blocks in the communications rooms to match those on the corresponding voice and data outlets. The font shall be at least .125-inch in height.
  7. Where a wireless access point is installed above an acoustical ceiling, label the ceiling grid frame below the access point, displaying the data port number and, if applicable, the access point identification number. Coordinate with the Owner for all access point identification information.
  8. All labels shall correspond to as-built drawings and to final test reports.
  9. Coordinate with Owner for specifications on labeling of all hardware, cabling, and related equipment prior to any testing.
  10. Label each distribution rack, block and other terminating equipment unit and field within that unit within 4 inches from the block or patch panel termination. Keep labels in a neat and orderly lineup.
  11. Label each connector and each discrete unit of cable-terminating and connecting hardware within connector fields, in wiring closets and equipment rooms. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.
  12. Post the cable schedule in a prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations.

13. Provide electronic copy of final comprehensive schedules for project in software and format selected by Owner.
14. Refer to the following drawing for faceplate labeling:
15. All cable labels shall:
  - a. Be marked at each end, on the sheath indicating the Telecommunications Room and jack number to which the cable is wired.
  - b. Backbone cables shall be marked at each endpoint and at all intermediate pull/access points or junction boxes. Label shall indicate origination and destination Telecommunication Rooms, sheath ID and strand or pair range.
  - c. Meet the legibility, defacement, exposure and adhesion requirements of UL 969.
  - d. Be pre-printed or laser printed type.
  - e. Where used for cable marking, a label with a vinyl substrate and white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than that of the cable to which it is attached.
  - f. Where insert type labels are used, provide clear plastic covers to go over label.
  - g. The Contractor shall confirm specific labeling requirements with the Owner or Owner's Representative prior to cable installation or termination.

T. Documentation:

1. All cable inventory data documentation shall be submitted in format coordinated with and approved by Owner so that data can be incorporated into existing databases.
2. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.
3. Complete cross connect documentation is required. It shall include detailed documentation of each pair of all copper backbone cable and strand of fiber.

### 3.3 CABLE REQUIREMENTS BY OUTLET TYPE

- A. Cable quantities are indicated by outlet type designations such as A, B, C, etc.
1. Projector Type B (2D)
  2. Wireless access point Type B (2D)
  3. IP camera Type B (2D)
  4. Type A: Voice/Data outlet is defined as two (2) voice and two (2) data cables, terminated in a four-port faceplate, usually at a height of +36" A.F.F.
    - a. Typical installation: offices.
  5. Type B: (wall) Data outlet is defined as two (2) data cables, terminated in a four-port faceplate with two blanks, usually at a height of +18" A.F.F.
    - a. Typical Installation: classroom.
  6. Type B: (ceiling/confined space) Data outlet is defined as two (2) data cables, terminated in a two- port, plenum SMB above the ceiling space or confined space.
    - a. Typical Installation: access point, IP camera.
  7. Type C: (wall) Data outlet is defined as four (4) data cables, terminated in a four-port faceplate. Height varies with installation.
    - a. Typical installation: computer lab.
    - b. Typical Installation: LCD display, projector, security gutter.
  8. Type D: Voice outlet is defined as one (1) voice cable, terminated in a one-port metal faceplate, for wall-mount telephones at a height of +42" A.F.F.
    - a. Typical installation: classroom, corridor. Telephone clearance required as 12" on all sides from center jack.

### 3.4 FIBER LOSS BUDGET

- A. Total maximum loss budget for a 40 or 100 GbE link is 1.9 dB.
1. Re-do connections to achieve this budget.

### 3.5 CLEANING

- A. All surfaces, cabling, and hardware shall be kept clean and free of dust and debris.
- B. Clean as needed and protect as required to maintain this requirement.

### 3.6 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.
- B. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein.

### 3.7 FIELD QUALITY CONTROL

REFER TO SECTION 27 00 00

END OF SECTION



## SECTION 27 1600 - COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Requirements for connecting cords, devices and adaptors, supplementing requirements found in the related sections.
- B. Related Sections
  - 1. 270000: Communications
  - 2. 270526: Grounding and Bonding of Communication Systems
  - 3. 270536: Communication Cable Pathways
  - 4. 270810: Optical Fiber Testing and Measurement
  - 5. 270820: Copper Testing
  - 6. 271100: Communications Equipment Room Fittings
  - 7. 271300: Communications Backbone Cabling
  - 8. 271500: Communications Horizontal Cabling

#### 1.2 WORK INCLUDED

- A. The Work of this Section shall consist of the labor, materials and equipment required for furnishing and installing telecommunications patch cables and equipment cords as part of a complete and functional telecommunications system.
- B. All items specified or included in this section shall be furnished and installed by Telecommunications Contractor, wired and connected by Telecommunications Contractor and tested by Telecommunications Contractor, unless noted otherwise. "Contractor" as used herein shall mean Telecommunications Contractor or Telecommunications Contractor's sub-contractor.
- C. Communications Patch Cords, Station Cords, and Cross-Connect Wire
  - 1. Data cable assemblies for the horizontal cross-connect and the workstation shall match horizontal, patch panel, and jack Category.
  - 2. Data cable assemblies shall be factory-assembled by the manufacturer of the cabling system.
  - 3. Provide data backbone factory-terminated fiber optic cable assemblies (Duplex LC to LC duplex) using duplex XG 850nm laser-optimized 50/125µm and Single-mode cable cross-connect assemblies in equipment rooms.
  - 4. Provide patch cord quantities on shop drawings.

#### 1.3 COORDINATION

- A. Contractor shall furnish and install the following:
  - 1. Patch and Equipment cords, for both copper and fiber.
- B. Electrical Contractor shall furnish and install the following:
  - 1. Floor boxes, box covers, straps.
  - 2. Boxes above ceilings and box covers.
- C. Unless noted, the following items will be the responsibility of the Owner:
  - 1. All electronics and active data networking equipment, etc.
  - 2. Telephones, fax machines and modems, etc.
  - 3. PC's, printers, video display terminals, flat panel displays, etc.

- D. Contact the Owner's network and computer equipment personnel for specific instructions before starting Work.

## PART 2 - PRODUCTS

### 2.1 COPPER PATCH & EQUIPMENT CORDS

- A. Patch cables and equipment cords shall be factory pre-connectorized, TIA/EIA compliant matching horizontal cable specifications, 4 pair UTP, 8-position modular jack, and stranded conductors. Patch cables and equipment cords shall be able to withstand at least a minimum of 200 jack mating cycles without any transmission degradation.
- B. Provide all cords the same Category rating as cable, jacks and patch panels installed.
- C. Provide patch cable lengths as coordinated with Owner. For bidding purposes assume 50% for 2M, and 25% for 1M, & 3M lengths.
- D. Patch Cables For Equipment Rooms:
  - 1. Provide one UTP patch cable for each horizontal cable terminated on patch panels.
  - 2. Coordinate patch cable lengths and color with the Owner prior to ordering.
  - 3. Provide fifteen (15%) spare patch cables for each cable provided.

### 2.2 PROVIDE EQUIPMENT CORDS AS FOLLOWS:

- A. Copper IDF side:
  - 1. (1) 5' light blue copper patch cord for each D1 and D2 port in the IDF cabinet.
  - 2. (50) 5' gray copper patch cords.
  - 3. (50) 5' light blue copper patch cords for each PP pair feeding back to AV equipment racks.
  - 4. (25) 7' gray copper patch cords for each PP pair feeding back to the AV equipment racks.
  - 5. (25) 7' light blue copper patch cords for each PP pair feeding back to the AV equipment racks.
  - 6. (1) 5' white copper patch cord for each V1 and V2 port in the IDF cabinet.
- B. Station side:
  - 1. (1) 7' black copper patch cord for each D1 port.
  - 2. (1) 14' black copper patch cord for each D2 port.
  - 3. (50) 16' white copper patch cord for voice.

C. 2.3 –

### 2.3 FIBER OPTIC PATCH CORDS

- A. Provide the following:
- B. Patch cables and equipment cords shall be factory pre-connectorized, TIA/EIA compliant.
- C. Manufacturer: CommScope
  - 1. (10) 5 foot SC-SC yellow single mode duplex patch cords
  - 2. (10) 10 meter SC-LC single mode duplex patch cords.
- D. Confirm the following Cable Lengths Quantity mix TBD:
  - a. (1m) = 3.3'
  - b. (2m) = 6.6'
  - c. (3m) = 9.8'



PART 3 - EXECUTION

3.1 ADDITIONAL INFORMATION

- A. Refer to Section 27 00 00 for submittal and other general requirements

3.2 INSTALLATION

- A. Patch cords shall be delivered to the Owner in factory sealed packages.
  - 1. Coordinate on delivery timing with GC and Owner to ensure any circuits required for permit or occupancy certificates will be active and connected on time.
- B. Install all patch cords in accordance with the Owners I.T. Department or the person in charge of the telecommunications infrastructure.
  - 1. After discussion with Owner, provide matrix of patching from port to switch port.
- C. Bend radius of cables shall be maintained as recommended by the manufacturer and per BICSI standards.

END OF SECTION