



BIDDING DOCUMENTS  
FOR THE  
BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL  
VOLUME 1 of 1

INSTALLATION OF 7 RELOCATABLE BUILDINGS

AT

BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL  
17000 Haynes Street, lake Balboa, CA 91406  
In the Los Angeles Unified School District

Prepared by OWNER:

LOS ANGELES UNIFIED SCHOOL DISTRICT  
FACILITIES SERVICES DIVISION  
333 South Beaudry Avenue, 22<sup>nd</sup> Floor  
Los Angeles, California 90017

For OWNER:

LOS ANGELES UNIFIED SCHOOL DISTRICT  
Los Angeles, California  
November 2018

IDENTIFICATION STAMP  
DIV. OF THE STATE ARCHITECT

APP03 118599

AC N.V. FLS 16 SS EY  
DATE 11/6/18



Oscar E. Corea Jr., ARCHITECT



Jessica Yueh, ELECTRICAL ENGINEER



Phil Roberts, CIVIL ENGINEER



Kevin A Smola, MECHANICAL ENGINEER

BIDDING DOCUMENTS  
TABLE OF CONTENTS

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS .....	Number of Pages
00 0101 Project Title Page .....	01
00 0110 Table of Contents .....	03
DIVISION 01 - GENERAL REQUIREMENTS	
01 1100 Summary of the Work .....	05
01 1216 Phasing of the Work .....	04
01 1219 Phasing of the Work Appendix A.....	07
01 2100 Allowances.....	02
01 2513 Product Substitution Procedures.....	02
01 2613 Request for Clarification.....	02
01 2973 Schedule of Values .....	03
01 2976 Progress Payment Procedures.....	04
01 3113 Project Coordination .....	04
01 3119 Project Meetings.....	06
01 3213 Construction Schedule .....	11
01 3229 Project Forms.....	5
01 3300 Submittal Procedures.....	09
01 4213 Abbreviations, Symbols and Acronyms .....	11
01 4523 Testing and Inspection.....	15
01 5000 Construction Facilities and Temporary Controls.....	21
01 6000 Product Requirements .....	06
01 7123 Field Engineering.....	06
01 7329 Cutting and Patching .....	07
01 7836 Warranties.....	03
DIVISION 02 - EXISTING CONDITIONS	
02 4116 Demolition .....	04
DIVISION 03 - CONCRETE	
03 1000 Concrete Forming Accessories.....	05
03 2000 Concrete Reinforcing.....	05
03 3000 Cast-In-Place Concrete.....	19
DIVISION 04 - MASONRY	
04 2200 Concrete Unit Masonry .....	10

DIVISION 05 - METALS	
05 5000 Metal Fabrications .....	07
DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES	
06 1000 Rough Carpentry .....	11
DIVISION 07 - THERMAL AND MOISTURE PROTECTION	
07 1400 Fluid Applied Waterproofing .....	06
07 9200 Joint Sealants.....	07
DIVISION 08 - OPENINGS	
DIVISION 09 - FINISHES	
09 2423 Cement Plaster and Metal Lath.....	17
09 3013 Ceramic Tiling.....	13
DIVISION 10 - SPECIALTIES	
DIVISION 11 - EQUIPMENT	
DIVISION 12 - FURNISHINGS	
DIVISION 13 - SPECIAL CONSTRUCTION	
DIVISION 14 - CONVEYING EQUIPMENT	
DIVISION 21 – FIRE-SUPPRESSION	
DIVISION 22 – PLUMBING	
22 0513 Basic Plumbing Materials and Methods.....	28
22 0553 Plumbing Identification.....	05
22 1000 Plumbing .....	23
DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING	
DIVISION 26 - ELECTRICAL	
26 0126 Inspection Test and Acceptance.....	50
26 0500 Common Work Results for Electrical.....	06
26 0513 Basic Electrical Materials and Methods.....	15
26 0519 Low-Voltage Wires (600 Volt AC).....	06
26 0526 Grounding and Bonding.....	05
26 0533 Raceways and Boxes Fitting and Supports.....	13
26 0800 Electrical Systems Commissioning .....	09

## DIVISION 27 – COMMUNICATIONS

27 0126	Test and Acceptance Requirements for Structured Cabling .....	43
27 0127	Quality Assurance, Test and Acceptance Requirements for New and Exist. Facilities .....	28
27 1013	Structured Cabling (Existing Sites) .....	50
27 1014	Structured Cabling (New Sites) .....	52
27 5128	Public Address Systems (Auditoriums, Performing Art, Multi-Purpose Rooms MS and HS)	19

## DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

### DIVISION 31 – EARTHWORK

31 2316	Excavation and Fill for Paving .....	06
31 2323	Excavation and Fill for Utilities .....	06
31 2326	Base Course .....	03

### DIVISION 32 – EXTERIOR IMPROVEMENTS

32 1216	Asphalt Paving .....	05
32 1236	Seal for Bituminous Surfacing .....	02
32 1313	Site Concrete Work .....	03
32 3113	Chain Link Fences and Gates .....	13

### DIVISION 33 – SITE IMPROVEMENTS

END OF TABLE OF CONTENTS

## SECTION 01 1100

## SUMMARY OF WORK

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. The furnishing of all labor, materials, equipment, services, and incidentals necessary for Work of the **RELOCATION OF (4) 24x40 RELOCATABLE CLASSROOMS, (2) 12x40 RELOCATABLE RESTROOMS, AND (1) 12X40 RELOCATABLE OFFICE BUILDING**, at BIRMINGHAM COMMUNITY CHARTER SCHOOL located at **17000 Haynes Street**, Lake Balboa, California 91406, as set forth in the Construction Documents which include, but are not limited to, the Drawings, Addenda and Specifications.

## 1.02 RELATED REQUIREMENTS:

1. Section 01 1216: Phasing of the Work.
2. Section 01 3113: Project Coordination.
2. Section 01 3229: Project Forms.
3. Section 01 3213: Construction Schedule.
4. Section 01 5000: Construction Facilities and Temporary Controls.
5. Section 01 7123: Field Engineering.

## PART 2 - PRODUCTS (Not used)

## PART 3 - EXECUTION

## 3.01 USE OF PREMISES

- A. CONTRACTOR shall coordinate Work of all trades, Subcontractors, utility service providers, with OWNER and/or Separate Work Contract. CONTRACTOR shall sequence, coordinate, and perform the Work to impose minimum hardship on the operation and use of the existing facilities and/or Project site. CONTRACTOR shall install all necessary protection for existing improvements, Project site, property, and

new Work against dust, dirt, weather, damage, vandalism, and maintain and relocate all protection to accommodate progression of the Work.

- B. CONTRACTOR shall confine entrance and exiting to the Project site and/or facilities to routes designated by the OAR.
- C. Within existing facilities, OWNER will remove portable equipment, furniture, and supplies from Work areas prior to the start of Work. CONTRACTOR shall cover and protect remaining items in areas of the Work.
- D. CONTRACTOR is advised school may be in session during performance of the Work. CONTRACTOR shall utilize all available means to prevent generation of unnecessary noise and maintain noise levels to a minimum. When required by the OAR, CONTRACTOR shall immediately discontinue noise-generating activities and/or provide alternative methods to minimize noise generation. CONTRACTOR shall install and maintain air compressors, tractors, cranes, hoists, vehicles, and other internal combustion engine equipment with mufflers, including unloading cycle of compressors. CONTRACTOR shall discontinue operation of equipment producing objectionable noise as required by the OAR.
- E. CONTRACTOR shall furnish, install, and maintain adequate supports, shoring, and bracing to preserve structural integrity and prevent collapse of existing improvements and/or Work modified and/or altered as part of the Work.
- F. CONTRACTOR shall secure building entrances, exits, and Work areas with locking devices as required by the OAR.
- G. CONTRACTOR assumes custody and control of OWNER property, both fixed and portable, remaining in existing facilities vacated during the Work.
- H. CONTRACTOR shall cover and protect surfaces of rooms and spaces in existing facilities turned over for the Work, including OWNER property remaining within as required to prevent soiling or damage from dust, dirt, water, and/or fumes. CONTRACTOR shall protect areas adjacent to the Work in a similar manner. Prior to OWNER occupancy, CONTRACTOR shall clean all surfaces including OWNER property.
- I. CONTRACTOR shall not use or allow anyone other than OWNER employees to use facility telephones and/or other equipment, except in an emergency. CONTRACTOR shall reimburse OWNER for telephone toll charges originating from the facility except those arising from emergencies or use by OWNER employees.
- J. CONTRACTOR shall protect all surfaces, coverings, materials, and finished Work from damage. Mobile equipment shall be provided with pneumatic tires.

- K. CONTRACTOR is advised OWNER will award Separate Work Contracts at this Project site.
- L. CONTRACTOR shall not permit the use of portable and/or fixed radio's or other types of sound producing devices including walkmans and similar devices.

### 3.02 PROPERTY INVENTORY

- A. Property, OWNER intends to remove; will be removed by OWNER before a room or space is vacated for the Work. Before performing Work in each room or space, OAR and CONTRACTOR shall prepare a detailed initial written inventory of OWNER property remaining within, including equipment and telephone instruments and the condition thereof. OAR and CONTRACTOR shall retain a signed copy of the inventory dated and signed by both parties. Prior to subsequent OWNER occupancy of each such room or space, OAR and CONTRACTOR shall perform a final inventory of OWNER property and all discrepancies between the initial inventory and final inventory shall be the responsibility of CONTRACTOR.

### 3.03 FURNITURE, FIXTURES AND EQUIPMENT (MATERIALS) OWNER FURNISHED CONTRACTOR INSTALLED (OFCI)

- A. Certain materials identified in the Contract Documents as OWNER Furnished CONTRACTOR Installed, OFCI, will be delivered to the Project site by the OWNER.
- B. If designated in the Contract Documents to be OWNER furnished CONTRACTOR installed, (OFCI), CONTRACTOR shall unload, store, uncrate, assemble, install, and connect OWNER supplied materials.
- C. One-Hundred and Twenty days before the date the CONTRACTOR needs to have the OFCI materials on site, CONTRACTOR shall notify OWNER of the scheduled date for needed OFCI materials. Upon delivery to Project site, CONTRACTOR shall store OFCI materials inside rooms and/or protected spaces and will be responsible for security of OFCI materials until Substantial Completion. OAR will sign receipt or bill of lading as applicable.
- D. CONTRACTOR shall, within ten days after delivery, uncrate and/or unpack OFCI materials in presence of OWNER who shall inspect delivered items. OWNER shall prepare an inspection report listing damaged or missing parts and accessories. OWNER shall transmit one copy of the report to CONTRACTOR. OWNER will procure and/or replace missing and or damaged OFCI materials, as indicated in inspection report.
- E. CONTRACTOR shall install OFCI materials in the locations and orientation as indicated in the Contract Documents. CONTRACTOR shall verify exact locations with OAR before final installation of OFCI materials.

- F. If required, OAR will furnish setting and or placement drawings for OFCI materials.
  - G. CONTRACTOR shall install OFCI materials by proper means and methods to ensure an installation as recommended by the manufacturer. CONTRACTOR shall furnish and install all necessary fasteners and required blocking to properly install OFCI materials.
  - H. CONTRACTOR shall install OFCI materials with manufacturer recommended fasteners for the type of construction to which the OFCI materials are being fastened and/or anchored.
  - I. CONTRACTOR shall provide final connections of any electrical, signal, gas, water, waste, venting and/or similar items to OFCI materials. CONTRACTOR shall, prior to final connection, verify the operating characteristics of OFCI materials are consistent with the designated supply.
- 3.04 FURNITURE, FIXTURES AND EQUIPMENT (Materials) - OWNER furnished, OWNER installed (OFOI)
- A. Certain materials are identified in the Contract Documents as OWNER Furnished, OWNER Installed (OFOI)
  - B. On dates and during times designated by OWNER, CONTRACTOR shall provide clear off-loading, receiving, protected storage, and OWNER'S dumpster space areas for the use of OWNER or OWNER'S third party OFOI installation contractors. At such times, CONTRACTOR shall also make clear routes and access available to all rooms and spaces to receive OFOI materials.
  - C. On dates and during times designated by OWNER, CONTRACTOR shall provide access to the elevators for use of OWNER or OWNER'S third party OFOI installation contractors.
  - D. CONTRACTOR shall cooperate fully with OWNER or OWNER'S third part OFOI installation contractors.
  - E. CONTRACTOR may be requested by OWNER to provide supplemental labor and equipment to support OFOI activities. Such requests must be submitted in accordance with the change order clauses of Contract.
  - F. Immediately prior to mobilization of OWNER or OWNER'S third party OFOI installation contractors, OWNER shall document the condition of the Work in areas to be utilized for OFOI activities.

- G. CONTRACTOR shall not be responsible for damage caused by OWNER or OWNER'S forces. OWNER shall document the condition of the Work and report to CONTRACTOR any damage in areas utilized for OFOI activities.

END OF SECTION

**SECTION 01 1216  
PHASING OF THE WORK**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Requirements for phasing of Work include logistics, phasing, and completion of designated phases prior to commencement of subsequent phases.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 1100: Summary of Work.
- B. Section 01 1219: Phasing of Work – Appendix A.
- C. Section 01 3300: Submittal Procedures.
- D. Section 01 3113: Project Coordination.
- E. Section 01 3213: Construction Schedule.
- F. Section 01 5000: Construction Facilities and Temporary Controls.
- G. Section 01 7700: Contract Closeout.

**PART 2 - PRODUCTS (Not used)**

**PART 3 - EXECUTION**

**3.01 SUBMITTALS**

- A. CONTRACTOR shall submit a Project site logistics plans in accordance with and as required by this Section.

**3.02 LOGISTICS**

- A. Prior to commencement of Work, CONTRACTOR shall prepare and submit to OAR, a detailed Project site logistic plan, in same size and scale of Drawings, setting forth CONTRACTOR plan of Work relative to following, but not limited to, items:

1. Hauling route shall be in accordance with local ordinances a truck access route to and from Project site.
  2. The identification of any overhead wire restrictions for power, street lighting, signal or cable.
  3. Local sidewalk access and street closure requirements.
  4. Protection of sidewalk pedestrians and vehicular traffic.
  5. Project site fencing and access gate locations.
  6. Construction parking.
  7. Material staging or delivery areas.
  8. Material storage areas.
  9. Temporary trailer locations.
  10. Temporary service location and proposed routing of all temporary utilities.
  11. Location of temporary or accessible fire protection.
  12. Trash removal and location of dumpsters.
  13. Concrete pumping locations.
  14. Crane locations.
  15. Location of portable sanitary facilities.
  16. Mixer truck wash out locations.
  17. Traffic control signage.
  18. Perimeter and site lighting.
  19. Storm Water Pollution Prevention Plan – SWPPP.
  20. Stockpile or lay down areas.
  21. Security lighting
- B. Revised Project site logistic plan may be required by OAR for separately identified phases of Work as set forth in this Section.

- C. CONTRACTOR is responsible for securing and/or obtaining all approvals and permits from authorities having jurisdiction relative to any activities set forth in Article 3.02.A.

3.03 PHASING OF THE WORK

- A. Project will be constructed in separate Milestone increments, as identified or as described in this Section or Contract Documents. Phasing will also delineate Work to be completed in each designated phase. Unless otherwise approved or directed by OWNER, each phase shall be completed according to approved Baseline Schedule prior to commencement of next subsequent phase. CONTRACTOR shall incorporate and coordinate Work of Separate Work Contracts relative to this Project into the Phasing and Construction Schedule.
- B. CONTRACTOR shall install all necessary Work for, but not limited to, power, lighting, signal, HVAC, drainage, and plumbing systems in phased Work before completion of designated phase. All valves, pull boxes, stub outs, temporary capping, and other Work necessary for phased completion and operation of all necessary systems shall be provided whether or not such Work is specifically identified in Contract Documents.

3.04 PHASING OF THE WORK – GENERAL

- A. CONTRACTOR shall prepare Construction Schedule in order to complete Work and related activities in accordance with phasing plan as established in Appendix "A". CONTRACTOR shall include all costs to complete all Work within Milestones or Contract Time.
- B. OWNER will be seriously damaged by not having all Work completed within Milestones or Contract Time. It is mandatory Work be complete within Milestones or Contract Time.

3.05 PHASING OF THE WORK – SPECIFIC

- A. CONTRACTOR shall prepare Construction Schedule, and shall complete following, but not limited to Milestones, as shown in Section 01 1219 – Appendix A and within designated phases in accordance with following:
1. Phase 1 Mobilization – (# of days) calendar days: Milestones 1 & 3.
  2. Phase 2 Construction – (#days) calendar days: Milestone 2, 4-28.
  3. Phase 3 Administrative Closeout – (# of days) calendar days: Milestone 29.

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- B. The Contract Time shall be a total of (# days) calendar days from date of commencement of Contract Time.

END OF SECTION

INSTALLATION OF 7 RELOCATABLE BUILDINGS  
BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL

10/01/2011  
PHASING OF THE WORK  
01 1216-4

## SECTION 01 2100

## ALLOWANCES

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. This Section specifies administrative and procedural requirements governing Contract allowances.
  - 1 Allowances as set forth in the Specifications are to be used as compensation for items as set forth in this Section. The amounts listed in the schedule or Specifications are to be included in the base bid and shall be listed separately in the Schedule of Values and Application for Payment.
- B. Type of allowances includes the following:
  - 1. B-Permit as per Specification Section 01 3596.
  - 2. Sewer assessment facility fee as per Supplementary Conditions, Section 00 7300.
  - 3. Field Office Supplies as per Division 01 Section 01 5000, 3.11.

## 1.02 RELATED REQUIREMENTS

- A. Section 01 2973: Schedule of Values.
- B. Section 01 2976: Progress Payment Procedures.
- C. Section 01 3213: Construction Schedule.
- D. Section 01 3229: Project Forms.
- E. Section 01 5000: Construction Facilities and Temporary Controls.
- F. Divisions 02-49: Specifications.

## 1.03 ALLOWANCES

- A. Use the allowances only as authorized for OWNER purposes and only by an approved allowance disbursement form that indicate the amounts to be charged to the respective allowance amount.
- B. At Substantial Completion of the Work or at any time designated by the OAR, credit unused amounts remaining in the allowances to the OWNER by Change Order.

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1.04 ALLOWANCE DISBURSEMENT

- A. CONTRACTOR shall submit a request for allowance disbursement on an allowance disbursement form. Include all substantiating and/or required data along with the request. Utilize the allowance disbursement authorization form as set forth in the Project Forms Section 01 3239.
- B. The request shall have the requested amount listed as an allowance disbursement without CONTRACTOR overhead and markup.
- C. Once the OAR has accepted the disbursement, ARCHITECT and OAR will sign the allowance disbursement form.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 SCHEDULE OF ALLOWANCES

- A. Include in the base bid the following allowances in the following amounts:

<u>Section</u>	<u>Description</u>	<u>Amount</u>
SECTION 01 3596	B-PERMIT	{\$ <u>0.00</u>
SECTION 00 7300.	SEWER CONNECTION FEES	{\$ <u>0.00</u>
SECTION 01 5000.3.11	OFFICE SUPPLIES	{\$ <u>0.00</u>

END OF SECTION

## SECTION 01 2513

## PRODUCT SUBSTITUTION PROCEDURES

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. This Section includes administrative and procedural requirements for handling requests for substitutions submitted 60 days after the date established in the Notice of Award and pursuant to Article 6.14 of the General Conditions.

## 1.02 RELATED REQUIREMENTS

- A. Section 01 3239: Project Forms.
- B. Section 01 3300: Submittal Procedures.
- C. Section 01 6000: Product Requirements.
- D. Section 01 7700: Contract Closeout.

## PART 2 - PRODUCTS (Not used)

## PART 3 - EXECUTION

## 3.01 APPLICATION

- A. CONTRACTOR proposed changes in products or materials required by the Contract Documents 60 days or more after the Notice of Award are considered to be requests for substitutions. OAR will consider requests for substitution if a product is no longer manufactured or the OAR and ARCHITECT, after a diligent search have verified that product or material is not available to CONTRACTOR. The following are not considered to be valid requests for substitutions:
  - 1. Revisions to the Contract Documents requested by OAR or ARCHITECT.
  - 2. Specified options of products included in the Contract Documents.
  - 3. Substitutions requested on a "or equal" basis.

## 3.02 SUBMITTALS

- A. Transmit submittals as described in related Sections for each request for substitution.

1. Identify the product to be replaced in each request. Include related Specification Section and Drawing number.
2. Provide complete documentation denoting compliance with the requirements for substitutions, and the following information, as appropriate.
  - a. A detailed comparison of significant qualities of the proposed substitution with those specified in the Contract Documents. Significant qualities may include elements, such as performance, weight, size, durability, and visual effect.
  - b. Product Data, including Drawings, descriptions of products, fabrication, and installation procedures.
  - c. Samples, where applicable or requested.
  - d. CONTRACTOR certification the proposed substitution conforms to requirements of the Contract Documents in every respect and is appropriate for the applications indicated.
  - e. CONTRACTOR waiver of rights to an increase in the Contract Amount, Milestones and/or Contract Time that may subsequently become necessary because of the failure of the substitution to adequately perform.
3. If required, ARCHITECT will request additional information or documentation for evaluation. OAR will notify CONTRACTOR of acceptance or rejection of the substitution.
4. ARCHITECT will review and consider request for substitution and provide a recommendation to OAR
5. Where a proposed substitution involves and/or affects more than one Subcontractor, CONTRACTOR shall ensure each Subcontractor cooperates with the other Subcontractor involved to coordinate the Work, provide uniformity and consistency, and assure compatibility of all products.
6. CONTRACTOR submittal and ARCHITECT review of Shop Drawings, Product Data, material lists or Samples do not constitute an acceptable or valid request for substitution.

END OF SECTION

**SECTION 01 2613**  
**REQUEST FOR CLARIFICATION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Procedure for requesting clarification of the intent of the Contract Documents.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 1100: Summary of Work.
- B. Section 01 3113: Project Coordination.
- C. Section 01 3213: Construction Schedule.
- D. Section 01 3239: Project Forms.
- E. Section 01 7700: Contract Closeout.

**PART 2 - PRODUCTS (Not used)**

**PART 3 - EXECUTION**

**3.01 PROCEDURE**

- A. CONTRACTOR shall prepare a Request for Clarification on the form provided in Section 01 3239. CONTRACTOR shall transmit the Request for Clarification to ARCHITECT with a concurrent copy to the OAR.
- B. ARCHITECT response is a clarification of the intent of the Contract Documents and does not authorize changes in the Contract Amount, Milestones and/or Contract Time.
- C. A Request for Clarification may be returned with a stamp or notation "Not Reviewed," if:
  - 1. The requested clarification is ambiguous or unclear.
  - 2. The requested clarification is equally available to the requesting party by researching and/or examining the Contract Documents.
  - 3. CONTRACTOR has not reviewed the Request for Clarification prior to submittal.
- D. Allow a minimum of nine days for review and response time, after receipt by ARCHITECT and OAR. CONTRACTOR shall verify and is responsible in verifying ARCHITECT and OAR receipt of a Request for Clarification.

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- E. Changes or alterations to the approved drawings or specifications shall be made by means of addenda or change orders as per section 4-338 of the California Building Standards Commission's, California Administrative Code.

END OF SECTION

## SECTION 01 2973

### SCHEDULE OF VALUES

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Procedure for submission of a certified Schedule of Values for review and approval by the OAR.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 2100: Allowances.
- B. Section 01 2976: Progress Payment Procedures.
- C. Section 01 3113: Project Coordination.
- D. Section 01 3213: Construction Schedule.
- E. Section 01 3229: Project Forms.
- F. Section 01 3300: Submittal Procedures.

#### PART 2 - PRODUCTS (Not used)

#### PART 3 - EXECUTION

##### 3.01 PREPARATION

- A. Upon receipt of the Notice of Intent to Award, CONTRACTOR shall commence preparation of a Schedule of Values in accordance with the form included in Section 01 3229.
- B. CONTRACTOR shall coordinate the preparation of a Schedule of Values with preparation of the Construction Schedule as set forth in Section 01 3213. The corresponding values from the specification division totals on cost loaded schedule shall match with the approved Schedule of Values.
- C. Include the following Project identification on a certified Schedule of Values:
  - I. Project name and location.

2. Project Number.
  3. Contract #.
  4. CONTRACTOR name.
  5. Date of Submittal.
- D. The Schedule of Values shall be in tabular form with separate columns and shall include the following items:
1. Related Specification Section and Division.
  2. Description of Work.
  3. Name of Subcontractor, manufacturer or supplier.
  4. Dollar value, quantity and unit of measure of each line item.
  5. Percentage of Contract amount to nearest one-hundredth percent, adjusted to total 100 percent.
- E. Round amounts to the nearest whole dollar; the total shall equal the Contract Amount.
- F. Provide a breakdown of the Contract Amount in enough detail acceptable to OAR to facilitate continued evaluation of Application for Payment and progress reports. Coordinate with the Project Manual table of content and Schedule of Values form under Section 01 3229. Provide line items for subcontract amounts, where appropriate.
- G. Provide separate line items for items in the Schedule of Values for total installed value of that part of the Work.
- H. Provide separate line item for labor and material when required by the OAR.
- I. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item except the amounts shown as separate line items as indicated under Schedule of Values form under Section 01 3229.
- J. Temporary facilities and other cost items that are not direct cost of actual work-in-place shall be shown as separate line items as indicated under Schedule of Values form under Section 01 3229.
- K. An approved certified Schedule of Values shall serve as the basis for the monthly certified Application for Payment.

- L. If at any time, OWNER determines, in its reasonable discretion, that the schedule of Values does not approximate the actual cost being incurred by CONTRACTOR to perform the Work, CONTRACTOR shall prepare, for OAR approval, a revised Schedule of Values, which then shall be used as the basis for future progress payments. Without changing the Contract Amount, OWNER reserves the right to require CONTRACTOR:
  - 1. To increase or decrease amounts within the line items in the Schedule of Values; and,
  - 2. To conform the price breakdown to OWNER accounting practice.

3.02 SUBMITTAL

- A. CONTRACTOR shall submit five certified copies of a Schedule of Values for review and approval by the OAR at least 14 days before the first Application for Payment.
- B. OAR will review and if necessary, return the submitted Schedule of Values with summary comments noting items not in compliance with the requirements of the Contract Documents. CONTRACTOR shall revise the submitted Schedule of Values and return five copies within three days of receipt of summary comments.
- C. Signature by OAR shall constitute acceptance of the submitted Schedule of Values.
- D. An approved copy of the Schedule of Values by OAR will be transmitted to CONTRACTOR, and Inspector.

END OF SECTION

## SECTION 01 2976

## PROGRESS PAYMENT PROCEDURES

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES:

- A. This Section specifies administrative and procedural requirements for a certified Application for Payment.
  - 1. Coordinate the certified Schedule of Values and certified Application for Payment with, but not limited to, the Construction Schedule, submittal log, and list of Subcontractors.

## 1.02 RELATED REQUIREMENTS:

- A. Section 01 2100: Allowances.
- B. ~~Section 01 2300: Alternates (Bid Items)~~
- C. Section 01 2973: Schedule of Values.
- D. Section 01 3213: Construction Schedule.
- E. Section 01 3229: Project Forms.
- F. Section 01 7700: Contract Closeout.

## PART 2 - PRODUCTS (Not used)

## PART 3 - EXECUTION

## 3.01 APPLICATION FOR PAYMENT

- A. Each certified Application for Payment shall be consistent with previous applications and payments as reviewed by OAR, paid for by OWNER, and:
  - 1. The initial Application for Payment and Final Application for Payment at time of Substantial Completion involve additional requirements.
- B. Payment Application Times: The period of Work covered by each Application for Payment is payment date for each progress payment as specified in the General Conditions. The period covered by each Application for Payment is previous month.

- C. Payment Application Forms: Use OWNER provided forms for the Application for Payment.
- D. Application Preparation: Complete every entry on the form. Include execution by a person authorized to sign legal documents on behalf of CONTRACTOR. OAR will return incomplete applications without action.
- E. Transmittal: Submit a minimum of four signed and original copies of each certified Application for Payment to OAR. All copies shall be complete, including releases and similar attachments.
  - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to OAR.
- F. Initial Application for Payment within 60 days of issuance of Notice to Proceed: Administrative actions and submittals, that must precede or coincide with submittal for first certified Application for Payment include, but are not limited to, the following:
  - 1. Certified Schedule of Values.
  - 2. Performance and payment bonds.
  - 3. List of principal suppliers and fabricators.
  - 4. Worker Compensation certificates, if applicable.
  - 5. Auto Insurance, if applicable.
  - 6. Hazardous Material Insurance Certificates, if applicable.
  - 7. Construction Schedule.
  - 8. Submittal Schedule.
  - 9. Emergency Contact List.
  - 10. Copies of authorizations and licenses from governing authorities for performance of Work.
  - 11. Certified Payroll (Submitted directly to Labor Compliance in electronic format as specified by OWNER including hard copy).
  - 12. Storm Water Pollution Prevention Plan (SWPPP).
  - 13. Certification of Compliance with CEQA Mitigations.

- G. Applications for Payment: Administrative actions and submittals that must precede or coincide with submittal of Progress Applications for Payment include, but are not limited to, the following:
1. Certified Payroll (submitted directly to Labor Compliance in electronic format as specified by OWNER including hard copy).
  2. Updated and current Project Record Drawings (as-built).
  3. Monthly Construction Schedule (updated, submitted and approved).
  4. Approved Schedule of Values.
  5. List of Subcontractors (Payments Summary).
  6. Storm Water Pollution Prevention (SWPP) – Site Monitoring Report.
  7. Certification of Compliance with CEQA Mitigations.
- H. Final Application for Payment at Substantial Completion: Following OAR issuance of certificate of Substantial Completion, submit an Application for Payment:
1. Administrative actions, submittals and/or Work that shall precede or coincide with this application include:
    - a. Occupancy permits and similar approvals by authorities having legal jurisdiction over Work..
    - b. Removal of temporary facilities and services.
    - c. Testing, adjusting and balance records.
    - d. Removal of surplus materials, rubbish, and similar elements.
    - e. Meter readings.
    - f. Start-up performance reports.
    - g. OWNER training and orientations.
    - h. Operating and maintenance instruction manuals.
    - i. Preliminary Warranties, guarantees and maintenance agreements.
    - j. Delivery of extra materials, products and or stock.

- k. Change over information related to OWNER occupancy, use, operation, and maintenance.
- l. Final cleaning.
- m. Ensure that Work is completed.
- n. Advise on shifting insurance coverage.
- o. List of defective Work, recognized as exceptions to certificate of Substantial Completion.
- p. Change of door locks, including keys, to OWNER system.
- q. Certified Payroll (submitted directly to Labor Compliance in electronic format as specified by the OWNER including hard copy).
- r. Certification that all benefit contributions due and owing to appropriate union trusts has been paid by CONTRACTOR and Subcontractors, as specified by the Project Stabilization Agreement (PSA) and Article 6.49 of the General Conditions.
- s. Storm Water Pollution Prevention – Site Monitoring Reports, SWPP revisions, compliance certifications, and Notice of Termination (NOT) (see Section 01 7416).~
- t. Certification of Compliance with CEQA Mitigations.
- u. Waivers and releases for CONTRACTOR.

END OF SECTION

## SECTION 01 3113

## PROJECT COORDINATION

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. This Section specifies administrative and procedural requirements necessary for coordinating Work operations including, but not limited to, the following:
1. General coordination procedures.
  2. Coordination drawings.

## 1.02 RELATED REQUIREMENTS

- A. Section 01 1216: Phasing of the Work.
- B. Section 01 3213: Construction Schedule.
- C. Section 01 3300: Submittal Procedures.
- D. Section 01 4523: Test and Inspection.
- ~~E. Section 01 4525: Testing, Adjusting, and Balancing for HVAC.~~
- F. Section 01 7700: Contract Closeout.

## PART 2 - PRODUCTS (Not used)

## PART 3 - EXECUTION

## 3.01 COORDINATION

- A. CONTRACTOR shall coordinate operations included in various sections of Contract Documents to assure efficient and orderly installation of each part of Work. Coordinate Work operations included under related sections of Contract Documents that depend on each other for proper installation, connection, and operation of Work, including but not limited to:
1. Schedule construction operations in sequence required where installation of one part of Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
  3. Provide provisions to accommodate items scheduled for later installation.
  4. Prepare and administer provisions for coordination drawings.
- B. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required in notices, reports, attendance at meetings, and:
1. Prepare similar memoranda for OAR and Separate Work Contract where coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of Work. Such administrative activities include, but are not limited to, following:
1. Preparation of schedules.
  2. Installation, relocation, and removal of temporary facilities.
  3. Delivery and processing of submittals.
  4. Progress meetings.
  5. Project closeout activities.
- D. Conservation: Coordinate Work operations to assure operations are carried out with consideration given to conservation of energy, water, materials, and:
1. Salvage materials and equipment involved in performance of, but not actually incorporated into Work.

### 3.02 SUBMITTALS

- A. Coordination Drawings: CONTRACTOR shall prepare coordination drawings to coordinate the installation of products and materials fabricated, furnished and installed by separate entities, under different parts of the Contract. CONTRACTOR shall notify OAR and ARCHITECT of all major conflicts in writing, in a timely manner so that the design team can respond without construction delays. Coordination drawings shall address the following at a minimum:

1. Limitations in available space for installation or service. CONTRACTOR shall overlay plans of each trade and verify space requirements and conflicts between trades. Minor changes and adjustments that do not affect design intent shall be made by CONTRACTOR and shall be highlighted for ARCHITECT'S review.
  2. Incompatibility between items provided under different trades (such as difference in voltage between equipment specified under Divisions 22 and 23 and electrical power provided under Division 26.)
  3. Inconsistencies between drawings, specifications and codes (between trades and within each trade).
  4. Additional items required for existing facilities construction projects shall be designed and prepared from available as-built drawings that are verified through non-invasive and non-destructive, visual observation only. CONTRACTOR shall field verify actual existing conditions during and upon completion of demolition work and incorporate findings into preparation of co-ordination drawings. Minor changes and adjustments that do not affect design intent shall be made by Sub-Contractor and shall be highlighted for OAR and ARCHITECT'S reviews.
- B. Prepare coordination drawings in CAD with each trade on a separate layer, in specified color and scale. CONTRACTOR and each Subcontractor shall provide and forward reproducible copies and CAD drawing files in the order described here:
1. Structural shop drawings shall indicate location and sizes of columns, beams and other structural members, as well as wall, roof and slab penetrations, and will be provided to mechanical, electrical, low voltage and plumbing Sub-contractors for co-ordination. Structural items shall be indicated using black lines.
  2. ~~HVAC Subcontractor will indicate all ductwork, piping and equipment complete with installation and dimensioned service clearances, duct and pipe sizes, fitting types and sizes, top or bottom of duct and pipe elevations, distances of ducts, pipes and equipment from building reference points and hanger and support locations. Minor changes and adjustments that do not affect design intent shall be made by Subcontractor and shall be highlighted for OAR and ARCHITECT'S reviews. Forward drawings to plumbing Subcontractor for further co-ordination. HVAC items shall be indicated using orange lines.~~
  3. Plumbing Subcontractor will indicate all plumbing lines, and equipment complete with installation and dimensioned service clearances, pipe sizes,

fitting types and sizes, top or bottom of pipe elevations, distances of pipes and equipment from building reference points and hanger/support locations Co-ordinate with HVAC Subcontractor. Minor changes and adjustments that do not affect design intent shall be made by Sub-contractor and shall be highlighted for OAR and ARCHITECT'S reviews Upon completion drawings shall be forwarded to Fire Sprinkler Subcontractor for further co-ordination. All Plumbing items shall be indicated using blue lines.

4. ~~Fire sprinkler Subcontractor will indicate fire sprinkler piping and equipment complete with installation and dimensioned service clearances, pipe sizes, fitting types and sizes, top or bottom of pipe elevations, distances of pipes and equipment from building reference points and hanger or support locations. Co-ordinate with Plumbing and HVAC Subcontractors. Minor changes and adjustments that do not affect design intent shall be made by sub-contractors and shall be highlighted for OAR and ARCHITECT'S reviews. Upon completion drawings shall be forwarded to Electrical CONTRACTOR for further co-ordination. Fire sprinkler equipment shall be indicated using red lines.~~
5. Electrical and Low Voltage Subcontractors will indicate service and feeder conduit runs and other electrical equipment complete, including low voltage with installation and dimensioned service clearances, sizes, top or bottom of conduit and rack elevations, distances of conduits and equipment from building reference points and hanger and support locations. Co-ordinate with Fire Sprinkler, Plumbing and HVAC Subcontractors. Minor changes and adjustments that do not affect design intent shall be made by sub-contractors and shall be highlighted for OAR and ARCHITECT'S reviews. Upon completion drawings shall be forwarded to CONTRACTOR for further co-ordination. Electrical work shall be indicated in dark green lines. Low voltage work shall be indicated in light green lines.
6. CONTRACTOR will be responsible for the overall coordination review. As each coordination drawing is completed, CONTRACTOR will meet with OAR to review and resolve all conflicts on coordination drawings.
7. Coordination meetings will be held in Project field office of CONTRACTOR. CONTRACTOR is required to distribute Shop Drawings, cut sheets and submittals to Subcontractors where appropriate. Reviewed coordination drawings will be maintained in Project field office of CONTRACTOR. Meeting minutes shall be developed by CONTRACTOR and submitted to OAR within 5 days.

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END OF SECTION

INSTALLATION OF 7 RELOCATABLE BUILDINGS  
BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL

10/01/2011  
PROJECT COORDINATION  
01 3113-5

## SECTION 01 3119

## PROJECT MEETINGS

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. This Section specifies administrative and procedural requirements for Project meetings, including but not limited to, the following:
  - 1. Job start meeting.
  - 2. Pre-installation conferences.
  - 3. Progress meetings.
  - 4. Meetings as required by OAR.

## 1.02 RELATED REQUIREMENTS

- A. Section 01 1216: Phasing of the Work.
- B. Section 01 3113: Project Coordination.
- C. Section 01 3213: Construction Schedule.
- D. Section 01 3239: Project Forms.
- E. Section 01 3300: Submittal Procedures.

## PART 2 – PRODUCTS (Not used)

## PART 3 - EXECUTION

## 3.01 JOB START MEETING

- A. In accordance with General Conditions Article 2.6, OAR will schedule a job start meeting before starting the Work, at a time and date determined by OAR. Meeting shall be held at the Project site or another location as determined by OAR. Meeting will be held in order to review responsibilities, procedures, and other administrative requirements contained within the Contract Documents.
- B. Authorized representatives of OWNER, INSPECTOR, ARCHITECT, CONTRACTOR and other parties shall attend the meeting. All participants at the

meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda items shall include significant items which could affect progress of the Work, including, but not limited to the following:

1. Preliminary Construction Schedule.
2. Critical work sequencing.
3. Designation of responsible personnel.
4. Identification of OAR.
5. Procedures for processing field decisions.
6. Request for Proposal.
7. Request for Clarification.
8. Construction Directive and Change Order.
9. Procedures for processing Applications for Payment.
10. Prevailing wages.
11. Submittal and review of Shop Drawings, Product Data, material lists, and Samples.
12. Preparation of project record documents.
13. Use of the Project site and/or premises.
14. Parking availability.
15. Office, work, and storage areas.
16. Equipment deliveries and priorities.
17. Safety procedures.
18. First Aid.
19. Security.
20. Housekeeping.
21. Working hours.

22. Contract Compliance Officer.
  23. Insurance Services including OCIP.
  24. Environmental Health and Safety.
  25. Substantial Completion, Administrative Closeout and Contract Completion requirements and procedures.
  26. Procedures for Mandatory Dispute and Claim Resolution.
  27. Storm Water Pollution Prevention Plan (SWPPP).
  28. CEQA Compliance.
- D. OAR shall prepare and issue meeting minutes to attendees and interested parties no later than five calendar days after the meeting date.

### 3.02 PRE-INSTALLATION CONFERENCES

- A. CONTRACTOR shall coordinate and conduct pre-installation conferences at the Project site as required by related Sections of the Contract Documents.
- B. CONTRACTOR, manufacturers, and fabricators involved in or affected by the installation and its coordination or integration with other preceding and/or subsequent installations of Work shall attend the meeting. CONTRACTOR shall advise OAR, INSPECTOR, and ARCHITECT of scheduled meeting dates in order to secure their attendance.
  1. CONTRACTOR shall review the progress of construction activities and preparations for the particular activity under consideration at each pre-installation conference, including requirements for the following:
    - a. Contract Documents.
    - b. Options.
    - c. Related Construction Directives and Change Orders.
    - d. Purchases.
    - e. Deliveries.
    - f. Shop Drawings, Product Data, and quality-control samples.
    - g. Review of mockups.
    - h. Possible conflicts.

- i. Compatibility problems.
  - j. Time schedules.
  - k. Weather limitations.
  - l. Manufacturer's recommendations.
  - m. Warranty requirements.
  - n. Compatibility of materials.
  - o. Acceptability of substrates.
  - p. Temporary facilities.
  - q. Space and access limitations.
  - r. Governing regulations.
  - s. Safety.
  - t. Inspecting and testing requirements.
  - u. Required performance results.
  - v. Recording requirements.
  - w. Protection.
2. CONTRACTOR shall record significant discussions and directives received from each conference. CONTRACTOR shall, within three (3) calendar days after the meeting date, distribute the minutes of the meeting to all concerned parties, including but not limited to, OAR, INSPECTOR, and ARCHITECT.

### 3.03 PROGRESS MEETINGS

- A. Progress meetings will be held at the Project site at regular intervals, typically weekly, as determined by the OAR.
- B. In addition to representatives of CONTRACTOR, OWNER, and ARCHITECT, each Subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of the Work shall, if requested by OAR, be represented at these meetings. All participants at the conference shall be familiar with the Project and authorized to conclude all matters relating to the Work.

- C. Failure of CONTRACTOR to be so represented at any progress meeting which is held at a mutually agreed time or for which a written notice is given, shall not relieve CONTRACTOR from abiding by any and all OAR determinations or directives issued at such meeting.
- D. OAR will review and correct or approve minutes of the previous progress meeting and will review other significant items affecting progress. Topics for discussion as appropriate to the status of the Project include but are not limited to:
  - 1. Interface requirements.
  - 2. Construction Schedule.
  - 3. Sequence and coordination.
  - 4. Status of submittals / RFCs.
  - 5. Deliveries.
  - 6. Off-site fabrication.
  - 7. Access.
  - 8. Site utilization.
  - 9. Temporary Construction Facilities and Controls.
  - 10. Hours of work.
  - 11. Hazards and risks.
  - 12. Housekeeping.
  - 13. Quality of materials, fabrication, and execution.
  - 14. Unforeseen conditions.
  - 15. Testing and Inspection.
  - 16. Defective Work.
  - 17. Construction Directive.
  - 18. Request for Proposal.
  - 19. Change Order Proposals and Change Orders.
  - 20. Documentation of information for payment requests.

21. Application for Payment.
  22. Other items as required or as brought forth..
  23. Initial Notice of Start of Issue, Event, Condition, Circumstance, or Cause of Perceived Delay, Disruption, Interference, Hindrance, Acceleration. (Article 12.2.1 of the General Conditions).
  24. Final Notice of End of Issue, Event, Condition, Circumstance, or Cause of Perceived Delay, Disruption, Interference, Hindrance, Acceleration (Article 12.2.2 of the General Conditions).
  25. Storm Water Pollution Prevention.
  26. CEQA Compliance.
- E. No later than three (3) calendar days after each progress meeting, OAR will prepare and distribute minutes of the meeting to each present and absent party. Include a brief summary, in narrative form, of progress, decisions, directives, actions taken, and all other issues since the previous meeting and report.
1. Schedule Updating: CONTRACTOR shall revise the Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized, and issue the revised schedule at the next scheduled progress meeting.

3.04 ADDITIONAL MEETINGS

- A. OAR, upon giving notice to the intended parties and without further obligation, may require additional meetings to discuss Work and/or Project related activities.

3.05 OWNER'S RIGHT TO RECORD

- A. CONTRACTOR agrees on behalf of itself and all its subcontractors that the OWNER may audiotape or videotape any meetings, training and any work at any time during the Project

END OF SECTION

**SECTION 01 3213**  
**CONSTRUCTION SCHEDULE**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Required procedures for the development of the Baseline Construction Schedule, Monthly Schedule Update, Four-Week Rolling Schedule, Recovery Schedules, Fragments and Time Extension requests.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 1100: Summary of Work.
- B. Section 01 1216: Phasing of the Work.
- C. Section 01 2973: Schedule of Values.
- D. Section 01 3300: Submittal Procedures.
- E. Section 01 3119: Project Meetings.
- F. Section 01 4523: Testing and Inspection.
- G. Section 01 7700: Contract Closeout.

**PART 2 – PRODUCTS**

**2.01 SCHEDULING SOFTWARE**

- A. CONTRACTOR shall utilize the latest version of Primavera Scheduling Software (P6) to employ the Critical Path Method (CPM) in the development and maintenance of the construction schedule. If the version of Primavera Scheduling Software (P6) used is greater than Version 15.1, the CONTRACTOR shall save & export schedules in Version 15.1 before submitting to Owner for review.
- B. All schedule calculation rules, auto cost rules and resource calculation rules shall be in a format acceptable to OAR. When schedule calculations are performed, the “Retained Logic” setting shall be used. CONTRACTOR shall use the zero “Decimal Places” setting. Finish Milestones shall be constrained with a “Finish on or before” type constraint in accordance with the dates stipulated in Specification Section 01 1219, Phasing of the Work, Appendix A. No “Mandatory Finish” type

constraints, no “Zero Free Float” constraints, no special hidden lag time between activities or other “float Suppression” techniques will be permitted. A schedule milestone constraint extending beyond Contract time or less than Contract time will not be acceptable. Rather, CONTRACTOR shall show any unused contract time as float (slack time) available to the project.

## PART 3 –EXECUTION

### 3.01 SCHEDULER QUALIFICATIONS

- A. CONTRACTOR shall have a scheduler with a minimum of 5 years direct experience in the development and maintenance of schedules.
- B. CONTRACTOR shall submit the resume of the construction scheduler to OWNER for review and approval. OAR has the right to refuse to accept the Scheduler based upon a lack of experience as required by this Section or based on lack of on-site performance and timeliness of schedule submittals. If OAR does not accept the proposed Scheduler, CONTRACTOR shall within one week of disapproval, propose another Scheduler who meets the experience requirements stated above.

### 3.02 PRE-CONSTRUCTION SCHEDULING CONFERENCE

- A. CONTRACTOR and CONTRACTOR Scheduler shall attend a pre-construction scheduling conference with OAR within 7 days after Notice of Award. CONTRACTOR Scheduler shall develop a construction schedule in accordance with this Specification Section. Scheduler shall cooperate with OAR and shall make themselves available for on-site meetings to develop, monitor, maintain and update the schedule in a timely manner.

### 3.03 SUBMITTALS

- A. Within seven calendar days after the effective date of the Notice to Proceed (or as stipulated in the milestones under Section 01 1219 Phasing of the Work Appendix A), CONTRACTOR shall submit to OWNER for review, a detailed Baseline Construction Schedule setting forth all requirements for complete execution of the Work. Include individual activities for the preparation of specific submittals, activities for owner review periods, activities for the procurement / fabrication period, installation activities, any applicable start-up & testing activities, and all contract milestones. With the exception of submittals and fabrication /procurement activities, each work activity shall range in duration from 1 workday minimum to a 10 workday maximum. The Scheduling system shall indicate all inter-relationships (logic ties) between the activities and shall be logically tied to all relevant milestones listed in Section 01 1219 Phasing of the Work Appendix A.

CONTRACTOR shall cost load the activities with a “budgeted cost” that totals up to the Contract award value. The format shall be coordinated with Specification Section 01 2973 (Schedule of Values), Specification Section 01 3229 (Project Forms), and Specification Section 01 2976 (Progress Payment Procedures).

- B. The level of detail indicated in the schedule shall be greater than that provided by Section 00 0110: Table of Contents of Contract Technical Specifications, including any Section 00 9113: Addenda. Duration and events indicated on schedule shall conform to phasing set forth in Section 01 1216 Phasing of the Work and shall show any area or building within a particular phase. Each activity description shall outline the specific work scope (by trade) and the location. Schedule shall indicate any and all Contract “milestone events” and other milestones agreed to by OWNER, but no other manually-imposed dates will be accepted unless approved by OWNER.
- C. CONTRACTOR shall allow for inclement weather in the Proposed Baseline Schedule by incorporating an activity titled “Rain Day Impact Allowance” as the last activity prior to the Substantial Completion Milestone. No other activities may be concurrent with it. The duration of the Rain Day Impact Allowance activity will be based on Table #1 below, and will be calculated from the Notice to Proceed until the original date of Substantial Completion.

Table #1: Cumulative Calendar Days “Rain Day Impact Allowance”:

January	6	July	0
February	5	August	0
March	5	September	1
April	4	October	1
May	1	November	3
June	0	December	5

- 1. When inclement weather at the Project site impacts Critical Path activities, CONTRACTOR may provide the OAR with a written request for a weather impact day describing the inclement weather delay on the Critical Path activities. The inclement weather delay must be clearly indicated by a 70 percent decrease in the field labor workforce hours on Critical Path activities on the day in question as indicated by CONTRACTOR’S Daily reports from the day in question and the scheduled work days prior to the day in question. Upon OAR’S independent confirmation of the amount of rainfall and impact, OAR will authorize CONTRACTOR to reduce the duration of the Rain Day Impact Allowance by one day.
- 2. Inclement weather on non-scheduled workdays shall not be granted as weather impact days. If CONTRACTOR asks to work a specific weekend or holiday and gives OAR advanced, written notification of critical path work to be performed and a substantial amount of precipitation occurs that

prevents the work from being performed, then that day can be claimed as a weather impact day. If the effects of inclement weather from a non-scheduled work day carry forward to a scheduled work day and impacts the Critical Path as noted above, then the scheduled work day will be considered impacted by weather. Any unused rain day allowance at the end of the project will be shown as available float to the Substantial Completion Milestone. Excusable, non-compensable time extensions will be granted for inclement weather to Substantial Completion milestone only after the weather impact area affecting the critical path work has exhausted the allotted cumulative Rain Day Impact Allowance. On projects that have multiple phases with defined start & finish dates, the cumulative rain impact allowance may be split up (pro-rated) into their designated phases upon OAR Approval.

- D. Activity Codes: As a minimum, the Activity Codes shown in the Table 1 below shall be assigned to each activity.

Name	Length	Description
TYPE	2	Type of activity (for example: mobilization, submittals, procurement/fabrication, construction, milestones, etcetera.)
AREA	2	Area or Building (for example: Bldg A, Building B, Courtyard, Athletic Fields, Street Work, etcetera.)
STAG	2	Stage (for example: Foundations, Superstructure, Exterior, Interior, Roof, Floor Number etcetera.)
SBST	2	Substage (a specific area within a stage such as: main electrical room, kitchen, room number, etcetera.)
RESP	7	Responsible Party (subcontractor and/or trade)
DIV	2	CSI Division
SPEC	5	CSI Specification Section number
	1.	OAR may require additional coding of activities. The mandatory activity code requirements listed in Table 1 are not to be construed as setting limits on CONTRACTOR'S management and coordination responsibilities, but are intended to guide CONTRACTOR in the administration of its contractual responsibilities.

- E. CONTRACTOR shall submit a color bar chart of all activities organized by Area (Location) and sorted by early start date in a graphically "left to right" manner. In addition, submit a Critical Path (Longest Path) color bar chart filter. Include the following column headings on the left hand side of both bar chart reports: activity ID, activity description, original duration, remaining duration, percent complete, start date, finish date, total float (slack time), and budgeted cost. CONTRACTOR shall also include an electronic file in its original format of the schedule. The electronic P6 file shall be saved in "XER" type format (version 15.1).

- F. Include a written schedule narrative sufficiently comprehensive to explain the basis of the CONTRACTOR'S approach to work. The written schedule narrative should include a paragraph of the project's Critical Path, the anticipated crew sizes (by trade), any planned equipment needed, a discussion on any long lead procurement/fabrication items, and any site logistic challenges.
- G. Seven calendar days after receipt of the OWNER'S review comments, CONTRACTOR shall revise & re-submit the Construction Schedule acceptable to OWNER. Once the Baseline Construction Schedule is approved, no changes will be allowed unless authorized by the OWNER.
- H. Failure of CONTRACTOR to submit a Construction Schedule in full compliance with the Contract Documents will result in a delay in progress payment processing. The Construction Schedule is to be used in evaluating progress and for monthly payment approval.
- I. Subsequently with each Monthly Progress Payment Request, CONTRACTOR shall deliver to OWNER a Monthly Schedule Update reflecting Work progressed to the end of the Progress Payment Request period (set as the last day of the month). Each such Monthly Schedule Update shall indicate actual progress to date in execution of the Work, together with a projected schedule for completion of all the remaining Work. CONTRACTOR shall copy & re-name the schedule file each month, status the activities with actual start and/or finish dates, adjust remaining durations, add re-submittals (if applicable), calculate the schedule with a "data date" to the end of the pay period, and submit the required reports outlined in Article 3.03 to OWNER. Each Monthly Schedule Update shall be submitted concurrently with the Monthly Pay Application no later than the fifth day of the succeeding month in accordance with Article 14 of the General Conditions. In updating the Schedule, CONTRACTOR shall not modify Activity ID numbers, activity descriptions, original durations, logic, schedule calculation rules/criteria, or the Activity Coding unless authorized by the OAR.
- J. All Schedule submittals are subject to review and acceptance by OWNER. OWNER retains the right to withhold progress payments in whole (or in part) until CONTRACTOR submits a Construction Schedule acceptable to OWNER.

## 3.05

## FOUR-WEEK ROLLING SCHEDULE

- A. At each Weekly Progress Meeting, CONTRACTOR shall present a Four-Week Rolling Schedule in Bar Chart format. It shall show one (1) week of actual and three (3) weeks of forecasted progress. The Four-Week Rolling Schedule shall be used as a basis for discussing progress and work planned during the three (3) weeks.
  - 1. The Four-Week Rolling Schedule shall be based on the most recent OAR Accepted Monthly Schedule Update. It shall include weekly updates to all

construction, submittal, fabrication and procurement, and separate work contract activities. CONTRACTOR shall ensure that it accurately reflects the current progress of the Work.

2. CONTRACTOR shall discuss at the Weekly Progress meeting the actual dates and any variances to critical or near critical activities.
3. Upon request by OAR, CONTRACTOR shall provide the Four-Week Rolling Schedule in electronic format.
4. If the Four-Week Rolling Schedule indicates activities are behind schedule, CONTRACTOR shall provide a Recovery Schedule in accordance with Article 3.06 below.
5. If the CONTRACTOR chooses to provide a Four-Week Rolling Schedule in a greater level of detail (by trade/subcontractor) outside of the monthly schedule database, then upon CONTRACTOR REQUEST and OAR written approval, the CONTRACTOR may proceed as long as the detailed activities roll-up to the contractual monthly schedule updates. These detailed activities will need to be linked to the overall Substantial Completion date as to properly forecast whether the project is ahead or behind schedule during the weekly Progress Meetings. The Four-Week Rolling Schedule must accurately reflect the work that is going on during the current week and must accurately reflect what will happen in the next three weeks.

### 3.06 RECOVERY SCHEDULES

- A. If a Monthly Schedule Update indicates negative float greater than ten (10) days on a critical path as result of events not predicated by Articles 10 and 12 of the General Conditions, CONTRACTOR shall prepare a Proposed Recovery Schedule demonstrating CONTRACTOR'S plan to regain the time lost. The Recovery Schedule shall be submitted either in advance of or concurrent with the Monthly Schedule Update and CONTRACTOR progress request. Both the Monthly Schedule Update and the Proposed Recovery Schedule shall be based on the same percentages of completion and actual dates accepted by OAR under Article 3.03.
- B. The Proposed Recovery Schedule shall be based on a copy of the Monthly Schedule Update for the calendar month during which the negative float first appears.
- C. The Proposed Recovery Schedule shall include a written narrative that identifies the causes of the negative float on the critical path and provides CONTRACTOR'S proposed corrective action to ensure timely completion of all Milestones and the Substantial Completion Date. CONTRACTOR'S corrective

actions shall include but are not limited to increasing concurrent operations, increasing labor, adding multiple shifts in a 24-hour period, and adding overtime.

- D. During any period of time when CONTRACTOR is found to be behind schedule by OAR, the Monthly Schedule Update described above shall become a weekly requirement (at no additional cost to OWNER) to provide a greater degree of focus on the timely completion of the Work. These Updates shall be submitted to OAR every Monday morning. When CONTRACTOR is deemed by OAR to be back on schedule, CONTRACTOR may revert to submitting the schedule monthly.
- E. CONTRACTOR'S progress payment may not be processed until OAR accepts the Proposed Recovery Schedule. Following such an acceptance, the Proposed Recovery Schedule will be known as the Recovery Schedule and future Work will be performed by CONTRACTOR in accordance with it.

## 3.07

## FRAGNETS AND TIME EXTENSION REQUESTS

- A. Float is not for exclusive use or benefit of either OWNER or CONTRACTOR but is an expiring resource available to both parties on a non-discriminatory basis. If required to meet specified Milestones, either party may utilize float. Adjustments to Milestones or Contract Time will only be authorized by Change Order and only to the extent the claimed adjustments exceed total float along the most critical path of the current Monthly Schedule Update in effect at the time of the claimed adjustments. The claimed adjustments to the Milestones and/or Contract Time must also cause the Substantial Completion Date to exceed that currently indicated in the Monthly Schedule Update. No time extensions will be granted nor delay damages paid under contract until all available float is used and the CONTRACTOR obtains a Time Extension Request approval from the OAR in accordance with Article 1.12 in its entirety. CONTRACTOR claimed adjustments to an existing negative float path will not receive consideration until the activity with the highest negative float is driven even further negative.
  - 1. Claimed adjustments to the Milestones or Contract Time will be administered in conjunction with those set forth in the General Conditions.
- B. Pursuant to the float sharing requirements of this Section, the use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, and extended activity times or durations are prohibited. The use of float time disclosed or implied by the use of alternate float suppression techniques shall be proportionally shared to benefit OWNER and CONTRACTOR. The use of any technique solely for the purpose of suppressing float will result in OWNER rejection of the submitted Monthly Schedule Update.
- C. In the event CONTRACTOR believes the Project has suffered an adverse impact arising from events predicated by Articles 10 and 12 of the General Conditions, CONTRACTOR may prepare a Time Extension Request by submitting a Schedule

Fragnet and a written narrative outlining the detail of the impact. A Schedule Fragnet must demonstrate a critical path delay. Such a delay must adversely impact the Substantial Completion Date for CONTRACTOR to receive a time extension. To demonstrate such an impact successfully, CONTRACTOR shall prepare a Schedule Fragnet based on a copy of OWNER accepted Monthly Schedule Update for the calendar month during which the adverse impact occurred. This "copy" of the OWNER accepted Monthly Schedule Update shall however first be updated (by OWNER and CONTRACTOR jointly) with both Percentages of Completion and Actual Dates up to the day the delay commenced. This process will provide the "pre-delay" project status. Once OWNER and CONTRACTOR have agreed to the "pre-delay" project status, CONTRACTOR should make a copy of this "pre-delay" schedule and this copy is to be the starting point for CONTRACTOR'S Schedule Fragnet development. OWNER will evaluate the activities, logic, durations, etcetera, in the Schedule Fragnet and will evaluate if the adverse impact arose from events described by Articles 10 and 12 of the General Conditions. The Fragnet shall also include CONTRACTOR-caused delays that affect the critical or near critical path in the network and should be accounted for in the Time Impact Analysis if overlapped at any point in time with OWNER-caused delay. If rain impact days were granted between the Start and Finish of OWNER-caused delay period, they should be accounted for in the Time Impact Analysis as well. Provided OWNER determines such an impact occurred, CONTRACTOR may be due a time extension equal to the number of proportioned days of variance/delay that resulted to the Substantial Completion Date.

- D. Activities added into a Schedule Fragnet to demonstrate the impact of adverse event shall be assigned a unique activity code. The Schedule shall be organized by this unique activity code.
- E. The Schedule Fragnet shall incorporate logic ties that are accurately reflective of the adverse event to pre-event predecessor activities and post event successor activities.
- F. The format and components of a Schedule Fragnet submittal shall be in accordance with this Section and Articles 10 and 12 of the General Conditions. It is crucial for the Fragnet to be submitted within the same month of discovery so it can be resolved during the monthly schedule update review. The notice shall be transmitted to OAR within the stipulations outlined in Article 12 of the General Conditions.
- G. If OWNER accepts CONTRACTOR'S Schedule Fragnet and an extension is granted, a Change Order will be prepared. OWNER will advise what change order number the time extension will become. When CONTRACTOR receives this Change Order number, all the activities added to the Schedule Fragnet shall be given Activity Identification Numbers that corresponds with the Change Order number. CONTRACTOR shall cost load the activities if required by OWNER. If

resource loading is required, the resource loading shall include a breakdown of labor, material, and equipment quantities.

- H. If OWNER rejects CONTRACTOR'S Schedule Fragnet in part based on improper forecast logic or activity tasks then it shall be revised accordingly to conform to OWNER'S review comments and be re-submitted. If the forecast logic and activity tasks cannot be agreed to then the pre-delay schedule outlined in Article 3.07, C shall be compared to the actual as-built data in the succeeding month of the encountering issue, event, condition, circumstance, and/or cause. The variance to the project between the pre-delay and post delay schedules shall be discussed in CONTRACTOR'S written narrative and proportioned between the different parties involved in the delay.
- I. If OWNER rejects CONTRACTOR'S Schedule Fragnet in whole then CONTRACTOR may follow the procedures set forth in Article 16 of the General Conditions.

### 3.08 PAYMENT FOR SCHEDULING

- A. The Work of this Section will be included as part of the bid price.
- B. Preparation, revising, maintenance, and compliance with this Section and Section 01 2973 is an integral part of the Contract Documents and is specified to have a minimum value equal to 2 percent of the original Contract Amount. This amount shall be proportionally cost loaded into two activities in both the Proposed Baseline Schedule and the Schedule of Values described in Section 01 2973. One activity for the "Baseline Schedule" and the other activity for the "Monthly Schedule Update Process" as follows:
  - 1. CONTRACTOR may allocate thirty percent (30 percent) of the total scheduling cost and place in the "Baseline Schedule" activity. It can then be billed against when the OAR accepts the Proposed Baseline Schedule as the Baseline Schedule.
  - 2. The remaining seventy percent (70 percent) may be cost loaded into the "Monthly Schedule Update Process" activity. This amount may be billed in equal monthly increments. The amount of those increments is determined by dividing the remaining cost by the total number of months in the Contract Time. Payment of these incremental amounts is contingent upon OAR acceptance of CONTRACTOR Monthly Schedule Updates, Recovery Schedules, Four-Week Rolling Schedules, Fragnets, Time Impact Analysis, and the updated Log of Required Submittals.
  - 3. The CONTRACTOR shall anticipate in their base contract scope that numerous Fragnets and written time impact analyses will be required during the duration of the project with the Monthly Schedule Updates.

Requests for extra scheduling services will not be considered until the CONTRACTOR demonstrates that all of the costs stipulated in Article 3.08, B has been expended.

### 3.09 FAILURE TO COMPLY WITH REQUIREMENTS

- A. At any time during the project if CONTRACTOR fails to comply with the specified requirements, OWNER reserves the right to engage independent estimating and scheduling consultants to fulfill these requirements. Upon notice to CONTRACTOR, OWNER shall assess against CONTRACTOR, incurred costs for these additional services.
- B. In such an event, OWNER will require, and CONTRACTOR shall participate and provide requested information to ensure the resulting Milestones Schedule accurately reflects CONTRACTOR's plan to execute the Work in compliance with the Contract Documents. If it becomes necessary for OWNER to recommend logic or duration revisions as a result of CONTRACTOR failure to furnish acceptable data, and if CONTRACTOR has objections to the recommendations, CONTRACTOR shall provide notice to OWNER within three days and CONTRACTOR shall provide an acceptable alternate plan. If CONTRACTOR fails to so note any objections and provide an acceptable alternate plan, or if CONTRACTOR implements the recommendations of OWNER without so noting any objections, CONTRACTOR will be deemed to have waived all objections and concurred with the recommended logic/duration revisions provided by ARCHITECT and/or OWNER.
- C. Submittal of any Monthly Schedule Updates are subject to review and acceptance by OWNER. OWNER retains the right, including, but not limited to Article 14 of the General Conditions, to withhold progress payments in whole or part until CONTRACTOR submits a Monthly Schedule Update acceptable to OWNER. If a Monthly Schedule Update is "Rejected" due to the OWNER not receiving a satisfactory schedule that accurately reflects the on-going work activities, the OWNER will mandate a separate meeting with the CONTRACTOR and approved Scheduler to remedy the non-conformance. If after the 2nd consecutive month the OWNER still has to "Reject" the monthly Schedule update due to non-conformance, then the CONTRACTOR'S Scheduler will need to be replaced at no additional cost to the OWNER. CONTRACTOR shall within one week of disapproval, propose another Scheduler who meets the required experience.

### 3.10 CONTRACTOR RESPONSIBILITY

- A. Nothing in this Section shall be construed to be a usurpation of CONTRACTOR authority, responsibility, and obligation to plan and schedule Work as CONTRACTOR deems necessary, subject to all other requirements of the Contract Documents.

- B. CONTRACTOR shall provide at all times sufficient competent labor, materials, and equipment to properly carry on Work and to insure completion of each part in accordance with Construction Schedule and within time agreed. CONTRACTOR shall involve the subcontractors, manufacturers, and suppliers in the development and periodic updating of the schedule.

3.11 RECORD DOCUMENTS / FINAL AS-BUILT SCHEDULE

- A. Prior to Contract Completion of the Work, CONTRACTOR shall submit a final as-built schedule, and a time-scaled network diagram (bar chart) reflecting the actual dates of all activities. This shall be submitted prior to the final application of payment and prior to the request to release retention.

END OF SECTION

## SECTION 01 3229

## PROJECT FORMS

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. The following, but not limited to, administrative forms and documents listed in this Section are to be utilized in the administration of the Work. Upon CONTRACTOR request, OAR may approve the use of alternate forms. Electronic versions of these forms are available on the LAUSD website.
- B. From time to time, OWNER may release new revisions and new Project Forms. At any time during the Project, if requested by OAR, CONTRACTOR shall use the newly released Project Forms.

## 1.02 RELATED REQUIREMENTS

- A. Division 01: General Requirements.

## PART 2 - PRODUCTS (Not used)

## PART 3 - EXECUTION

## 3.01 FORMS

- A. The following examples of forms are contained within this Section:
  - 1. Allowance Disbursement Authorization.
  - 2. Application for Payment (2 pages)<sup>1</sup>.
  - 3. Certification of Compliance with Project Stabilization Agreement and Labor Compliance.
  - 4. Certification of Compliance with CEQA Mitigations.
  - 5. Certificate of Substantial Completion.
  - 6. Change Order.
  - 7. Change Order Proposal.
  - 8. Change Order Proposal – Compensable Delay Costs.
  - 9. Change Order Proposal Detail Sheet.

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<sup>1</sup> Application for Payment (Multiple Projects Form) is available from the OAR.

10. Change Order Proposal Guidelines.
11. Change Order Proposal – Labor Rate Calculation Form (Request for Rate Higher Than Fully burdened Labor Rates).
12. Conditional Waiver and Release – Final Payment.
13. Construction Directive.
14. Correction Notice.
15. Daily Construction Report.
16. Daily Time and Material Record.
17. Initial Notice of start of Issue. Event, Condition, Circumstance, or Cause of Perceived or Actual Delay, Disruption, Interference, Condition, Circumstance, or Cause of Perceived Delay, Disruption, Interference, Hindrance, Acceleration.
18. Final Notice of End of Issue, Event, Condition, Circumstance, or Cause of Perceived or Actual Delay, Disruption, Interference, Condition, Circumstance, or Cause of Perceived Delay, Disruption, Interference, Hindrance, Acceleration.
19. Five Day Notice.
20. List of Subcontractors.
21. Notice of Completion.
22. Notice of Partial Use or Occupancy.
23. Notice of Termination.
24. Notice to Proceed.
25. “Or Equal” Request.
26. OWNER Assessment Summary.
27. Property Inventory.
28. Request for Certification of Substantial Completion.
29. Request for Clarification.
30. Request for Proposal.
31. Request for Reduction of Retention.

32. Schedule of Values.
33. Storm Water Pollution Prevention – Site Monitoring Report.
34. Submittal Log.
35. Substitution Request.
36. Survey of Existing Site Conditions.
37. Transmittal.

### 3.02 PROCEDURES

- A. Allowance Disbursement Authorization: This form is used for the request and approval of Contract allowances.
- B. Application for Payment: This form is used in requesting a progress payment.
- C. Application for Payment (Multiple Projects): Alternate progress payment request form for contracts comprising more than one project.
- D. Certification of Compliance with Project Stabilization Agreement and Labor Compliance Code Section 1776: This form is used to certify that all contributions due and owing to appropriate trust funds have been paid by CONTRACTOR and all Subcontractors, as specified by the Project Stabilization Agreement (PSA) and General Conditions Article 6.49. This form is also used to certify that CONTRACTOR has submitted all certified payroll records mandated by Labor Code 1776, and General Conditions Article 6.49.
- E. Certification of Compliance with CEQA Mitigations: This form is used to certify that all CEQA requirements were complied with by CONTRACTOR.
- F. Certificate of Substantial Completion: This form is used according to Article 14 of the General Conditions.
- G. Change Order: This form is used to adjust the Contract Amount, Milestones or Contract Time.
- H. Change Order Proposal: This form is used to communicate proposed adjustments to the Contract Amount, Milestones or Contract Time.
- I. Construction Directive: This form is used to issue a Construction Directive.
- J. Correction Notice: This form is used to provide notice of defective Work.
- K. Daily Construction Report: This form is used to report daily Work activities and manpower levels of CONTRACTOR or Subcontractor.

- L. Daily Time and Material Record: This form is used to provide daily records as set forth in Article 11.11 of the General Conditions.
- M. Initial Notice of Start of Issue, Event, Condition, Circumstance, or Cause of Perceived Delay, Disruption, Interference, Hindrance, Acceleration: This form is used to provide notice as set forth in Article 12.2.1 of the General Conditions.
- N. Final Notice of End of Issue, Event, Condition, Circumstance, or Cause of Perceived Delay, Disruption, Interference, Hindrance, Acceleration: This form is used to provide notice as set forth in Article 12.2.2 of the General Conditions.
- O. Five Day Notice: This notice is used according to Article 15.3.2 of the General Conditions.
- P. List of Subcontractors: This form is used according to Article 14.2 of the General Conditions.
- Q. Notice of Completion: This form is used according to Article 14.17 of the General Conditions.
- R. Notice of Partial Use or Occupancy: This form is used according to Article 14.15 of General Conditions.
- S. Notice of Termination: Contractor shall submit a Notice of Termination (NOT) to the Los Angeles Regional Water Quality Control Board, LARWQCB. Provide a copy of NOT to OAR (See Section 01 7416).
- T. Notice To Proceed: This form is used to establish the date of Contract Time commencement and the date Contractor is authorized to commence performance of Contractor obligations.
- U. “Or Equal” Request: This form is used to submit a list of proposed “or equal” substitutions.
- V. Owner Assessment Summary: This form is used for all assessments or withholdings by the Owner, permitted under the Contract or required by law, including without limitation, stop notices, prevailing wage violations, liquidated damages, additional consultant services, OCIP premiums, etc.
- W. Property Inventory: This form is used to establish Owner property in a space.
- X. “Request for Certification of Substantial Completion”: This form is used according to Article 14 of the General Conditions
- Y. Request for Clarification: This form is to be used for clarification of the intent of the Contract Documents.
- Z. Request for Proposal: This form is used to request a proposed adjustment in the Contract Amount, Milestones or Contract Time in response to the Work contained within the Request for Proposal.

- AA. Request of Reduction of Retention: This form is used according to Article 14.8 of the General Conditions.
- BB. Schedule of Values: This form is used to establish the basis of the certified Application for Payment.
- CC. Storm Water Pollution Prevention Plan (SWPPP): Site Monitoring Reports: These forms are used to certify that construction activities are in compliance with SWPPP (see Section 01 7416).
- DD. Submittal Log: This form is a format for the listing of the required submittals.
- EE. Substitution Request: This form is used to submit proposed substitutions of materials or equipment no longer manufactured or which cannot be acquired from existing inventories.
- FF. Transmittal: This form is used for transmission of items related to the Contract.

END OF SECTION

**SECTION 01 3300**  
**SUBMITTAL PROCEDURES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Administrative and procedural requirements for submittals required for the Work, including but not limited to; Shop Drawings, Product Data, Samples, material lists, and quality control items.
- B. Throughout the Contract Documents, the minimum acceptable quality of materials, fabrication, and execution have been defined by the name and catalog number of a manufacturer and by reference of recognized industry standards.
- C. To ensure that specified products are furnished and installed in accordance with the design intent, procedures have been established for submittal of design data and for its review by ARCHITECT, OAR and others.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 1216: Phasing of the Work.
- B. Section 01 2513: Product Substitution Procedures.
- C. Section 01 2973: Schedule of Values.
- D. Section 01 2976: Progress Payment Procedures.
- E. Section 01 3113: Project Coordination.
- F. Section 01 3213: Construction Schedule.
- G. Section 01 3239: Project Forms.
- H. Section 01 4523: Testing and Inspection.
- I. ~~Section 01 4525: Testing, Adjusting, and Balancing for HVAC.~~
- J. Section 01 5000: Construction Facilities and Temporary Controls.

- K. Section 01 7123: Field Engineering.
- L. Section 01 7329: Cutting and Patching.
- M. Section 01 7416: Storm Water Pollution Prevention.
- N. Section 01 7700: Contract Closeout.
- O. Section 01 7836: Warranties.

## PART 2 – PRODUCTS (Not used)

## PART 3 - EXECUTION

### 3.01 PROCEDURES

- A. CONTRACTOR is required to review and approve every submittal and shop drawing prior to transmittal and delivery to ARCHITECT. Should CONTRACTOR determine a submittal contains errors, or does not meet the requirements of the contract, CONTRACTOR shall immediately return the submittals and shop drawings to the producer and expedite the corrections prior to transmitting the submittal to ARCHITECT. Submittals shall not be used by CONTRACTOR to request clarifications or submit questions. CONTRACTOR will affix stamp to each submittal certifying CONTRACTOR has performed, at minimum, the following:
  - 1. Verified the submittal is complete in all respects and follows the requirements of the Contract Documents without variance.
  - 2. Confirmed that no substitutions have been included. If substitutions are included, CONTRACTOR shall eliminate them from the submittal and process them in accordance with Section 00 7000 General Conditions Article 6.14.
  - 3. Identified any variances from the requirements of the Contract Documents and confirmed that the identified variance meets, but does not exceed the allowable limitations or tolerances as defined in these specifications.
  - 4. Verified that all submitted materials, dimensions and tolerances are compatible with existing or planned conditions of the Work in order to erect, fabricate, or install the submitted assembly in conformance with the requirements of the Contract Documents.

5. Coordinated and verified that the dimensions match CONTRACTOR measured field or installation conditions.
  6. Coordinated and verified that the products of separate manufacturers required within any field produced assembly are compatible in all respects for such assembly.
  7. Packaged together all related submittals or shop drawings where such is necessary for a comprehensive ARCHITECT review.
- B. CONTRACTOR shall package each submittal appropriately for transmittal and handling. Transmittal format shall be as required by OWNER. CONTRACTOR shall transmit and deliver six sets of each submittal or re-submittal to ARCHITECT, two of which shall be returned to CONTRACTOR. Some specifications may require additional copies be provided. CONTRACTOR shall provide the OWNER additional copies as specified or as requested by OAR. ARCHITECT will not accept submittals received from sources other than from CONTRACTOR.
- C. After ARCHITECT'S review, ARCHITECT will transmit submittals to OAR and OAR shall further distribute to CONTRACTOR, INSPECTOR and others as required. Work shall not commence, unless otherwise approved by OAR, until approved submittals are transmitted to CONTRACTOR.
- D. CONTRACTOR shall clearly identify any deviations from the Contract Documents on each submittal. Any deviation not so noted even though stamped reviewed is not acceptable.
- E. CONTRACTOR shall coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities requiring sequential activity.
- F. Timing of Submittals:
1. In accordance with General Conditions, CONTRACTOR shall submit to ARCHITECT, with copy of transmittal to the OAR, those Shop Drawings, Product Data, diagrams, materials lists, Samples and other submittals required by the Contract Documents.
  2. The scheduling of submittals shall be sequenced to support the progress of the Work, and shall be:
    - a. Submitted sufficiently in advance of construction, fabrication or installation in order to allow time for transmittal, review, modification, correction, (and resubmission and re-review when required.)

- b. Phased with adequate time between submittals in order to allow for proper review by the ARCHITECT without negative impact to the Milestones Schedule.
  - 3. CONTRACTOR shall coordinate submittal of related items and ARCHITECT reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received by ARCHITECT.
  - 4. CONTRACTOR shall revise, update and submit submittal schedule to ARCHITECT and OAR on the first of each month, or as required by OAR.
  - 5. CONTRACTOR shall allow in the Construction Schedule, at least sixteen days for ARCHITECT review following ARCHITECT receipt of submittal. For mechanical, plumbing, electrical, low voltage, fire sprinklers, door and hardware, and other submittals requiring joint review with OAR, CONTRACTOR shall allow a minimum of eighteen days following ARCHITECT receipt of submittal. Deferred approval items shall be allowed additional time for DSA review.
  - 6. No adjustments to the Contract Time or Milestones will be authorized because of a failure to transmit submittals to ARCHITECT sufficiently in advance of the Work to permit review and processing or where CONTRACTOR fails to provide ARCHITECT submittals on related items.
  - 7. In case of product substitution, Shop Drawing preparation shall not commence until such time as OWNER accepts or rejects the proposed substitution in accordance with the procedures described in the General Conditions.
- G. If required, resubmit submittals in a timely manner. Resubmit as specified for initial submittal but identify as such. Review times for re-submitted items shall be as per the time frames for initial submittal review.
- H. Shop Drawing preparation shall not commence until such time as CONTRACTOR receives Product Data acceptance.
- I. ARCHITECT will stamp each submittal with a uniform, action stamp. ARCHITECT will mark the stamp appropriately to indicate the action taken, as follows:
- 1. Final Unrestricted Release: When ARCHITECT marks a submittal "Reviewed" the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.

2. Final-But-Restricted Release: When ARCHITECT, or authorized agent, marks a submittal "Reviewed as Noted," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
3. Returned for Re-submittal: When ARCHITECT, or authorized agent, marks a submittal "Rejected, Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat as necessary to obtain different action mark. In case of multiple submittals covering same items of Work, CONTRACTOR is responsible for any time delays, schedule disruptions, out of sequence Work, or additional costs due to multiple submissions of the same submittal item. Do not use, or allow others to use, submittals marked "Rejected, Revise and Resubmit" at the Project site or elsewhere where Work is in progress.
4. Other Action: Where a submittal is for information or record purposes or special processing or other activity, ARCHITECT, or authorized agent, will return the submittal marked "Action Not Required".

## 3.02

## SHOP DRAWINGS

- A. Shop Drawings are original drawings prepared by CONTRACTOR, Sub-contractor, supplier, or distributor illustrating some portion of Work by showing fabrication, layout, setting, or erection and shall not be based on reproduced Contract Documents or copied standard information.
- B. Produce Shop Drawings to an accurate scale that is large enough to indicate all pertinent features and methods. Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 24 by 36 inches.
- C. Shop Drawings shall include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings. Include the following information:
  1. Dimensions.
  2. Identification of products and materials included by sheet and detail number.
  3. Compliance with specified standards.

4. Notation of coordination requirements.
  5. Notation of dimensions established by field measurement.
- D. Provide a space of approximately 4 by 5 inches on the label or beside the title block on Shop Drawings to record CONTRACTOR and ARCHITECT review, and the action taken. Include the following information on the label for processing and recording action taken:
1. Project name.
  2. Date.
  3. Name and address of ARCHITECT.
  4. Name and address of CONTRACTOR.
  5. Name and address of Subcontractor.
  6. Name and address of supplier.
  7. Name and address of manufacturer.
  8. Name and title of appropriate Specification section.
  9. Drawing number and detail references, as appropriate.
- E. Unless otherwise agreed to or indicated in individual Specification sections, submit a sufficient number of sets to allow for adequate distribution to CONTRACTOR, Sub-Contractor, supplier, manufacturer and fabricators plus four (4) sets (two sets to be retained by ARCHITECT, one set to the INSPECTOR and one set to OAR).

### 3.03 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of Work or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, wiring diagrams, schedules, illustrations, or performance curves.
1. Mark each copy to show or delineate pertinent materials, products, models, applicable choices, or options. Where Product Data includes information

on several products that are not required, clearly mark copies to indicate the applicable information. Include the following information:

- a. Manufacturer's printed recommendations.
  - b. Compliance with trade association standards.
  - c. Compliance with recognized testing agency standards.
  - d. Application of testing agency labels and seals.
  - e. Notation of dimensions verified by field measurement.
  - f. Notation of coordination requirements.
  - g. Notation of dimensions and required clearances.
  - h. Indicate performance characteristics and capacities.
  - i. Indicate wiring diagrams and controls.
2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed by CONTRACTOR.

C. Required Copies and Distribution: Same as denoted in Article 3.02.E.

3.04 SAMPLES

A. Procedure:

1. Submit Samples of sufficient size, quantity, cured and finished and physically identical to the proposed product or material. Samples include partial or full sections or range of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches denoting color, texture, and/or pattern.
  - a. Mount or display Samples in the manner to facilitate review of qualities indicated. Include the following:
    - 1) Specification section number and reference.
    - 2) Generic description of the Sample.

- 3) Sampling source.
  - 4) Product name or name of manufacturer.
  - 5) Compliance with recognized standards.
  - 6) Availability and delivery time.
2. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
    - a. Where variations in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three (3) multiple units that show the approximate limits of the variations.
    - b. Refer to other Specification sections for requirements for Samples that illustrate materials, fabrication techniques, assembly details, connections, operation, and similar construction characteristics.
    - c. Refer to other sections for Samples to be returned to CONTRACTOR for incorporation into the Work. Such Samples must be undamaged at time of installation. On the transmittal indicate special requests regarding disposition of Sample submittals.
    - d. Samples not incorporated into the Work, or otherwise not designated as Owner property, remain the property of CONTRACTOR and shall be removed from the Project site prior to Substantial Completion.
  3. Color and Pattern: Whenever a choice of color or pattern is available in a specified product, submit accurate color chips and pattern charts to OAR for review and selection.
  4. Number Required: Submit six, minimum, of each. Two will be returned to CONTRACTOR.
- B. When specified, erect field Samples and mock-ups at the Project site to illustrate products, materials, fabrications, or execution and to establish standards by which completed Work shall be judged.
- C. Maintain sets of Samples, as returned, at the Project site, for quality comparisons throughout the course of the Work. Sample sets may be used to obtain final acceptance of the Work associated with each set.

3.05           **QUALITY CONTROL SUBMITTALS**

- A. Submit quality control submittals, including design data, certifications, manufacturer's field reports, and other quality control submittals as required under other sections of the Contract Documents.
- B. When other sections of the Contract Documents require manufacturer's certification of a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.
- C. Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the represented company.
- D. Requirements for submittal of inspection and test reports are specified in other sections of the Contract Documents.

END OF SECTION

## SECTION 01 4213

## ABBREVIATIONS, SYMBOLS AND ACRONYMS

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. List of abbreviations, symbols, and acronyms of societies, institutes, and associations generally appearing in the Contract Documents.

## 1.02 RELATED REQUIREMENTS

- A. Division 01 - General Requirements

## PART 2 - PRODUCTS (Not applicable)

## PART 3 - EXECUTION

## 3.01 ABBREVIATIONS

ac	Alternating current
AFF	Above Finish Floor
amp	ampere
BOOTP	Bootstrap Protocol
BTU	British thermal unit
C	Degrees Centigrade, Celsius
Cat 6	Category 6, unshielded twisted pair cabling
CFC	Chlorofluorocarbon
cfh	Cubic feet per hour
cfm	Cubic feet per minute
cm	Centimeter
Co.	Company
COP	Coefficient of performance
Corp.	Corporation
d	Penny
db.	Decibel
DB	Dry bulb
dc	Direct current

EER	Energy efficiency ratio
F	Degrees Fahrenheit
fpm	Feet per minute
ft	Foot or feet
GA	Gage
gph	Gallons per hour
gpm	Gallons per minute
HP	Horsepower
HVAC	Heating, ventilating and air conditioning
Hz	Hertz
ID	Inside Diameter
Inc.	Incorporated
IR light	Infrared light
Kbps	Kilobits per Second
KHz	Kilohertz
Kip	thousand pounds
Ksf	Thousand pounds per square foot
Ksi	Thousand pounds per square inch
Kv	Kilovolt
KVA	Kilovolt amperes
KW	Kilowatt
KWH	Kilowatt hour
LF	Linear foot
Lb(s)	Pound(s)
LCD	Liquid Crystal Display
Lux	A standard unit of illumination measurement
Max	Maximum
MBH	1000 BTUs per hour
MHz	Mega hertz
mil	Thousandth of an inch
Min	Minimum
mm	Millimeter
mph	Miles per hour
NA	Not Applicable
NIC	Not in Contract
OC	On Center
OD	Outside Dimension

oz.	Ounce
PCF	Pounds per cubic foot
pH	Acidity-alkalinity balance
psf	Pounds per square foot
psi	Pounds per square inch
psig	Pounds per square inch, gage
PVC	Polyvinylchloride
RF	Radio frequency
rpm	Revolutions per minute
SF	Square foot
SS	Stainless Steel
SY	Square yard
V	Volts
W	Watts
WB	Wet bulb

## 3.02 SYMBOLS

#	Number or pound
'	Foot or feet
"	Inch(es)
%	Percent
°	Degree (Angle or Temperature)

## 3.03 ACRONYMS

AA	The Aluminum Association, Inc
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABMA	American Boiler Manufacturers Association
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
AEC	Automatic Echo Cancellation
AGA	American Gas Association
AGC	Automatic Gain Control

AGCIH	American Conference of Governmental Industrial Hygienists
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Movement and Control Association, Inc.
ANI	Automatic Number Identification
ANSI	American National Standards Institute
APA	APA – The Engineered Wood Association
API	Application Programming Interface
ARI	Air-Conditioning and Refrigeration Institute
ARS	Automated Route Selection
ARP	Address Resolution Protocol
ATSC	Advanced Television Systems Committee
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATBCB	Architectural & Transportation Barriers Compliance Board
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BBS	Backbone Switch
BGP	Border Gateway Protocol
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America
BICSI	Building Industry Consulting Services, International
BRI	Basic Rate Interface
CAL/OSHA	California Occupational Safety and Health Administration
CAC	Call Admission Control
CAS	Channel Associated Signaling
CAT 5e	Category 5e
CBC	California Building Code
CCR	California Code of Regulations
CCK	Complementary Code Keying
CDR	Call Detail Record

CEC	California Electrical Code
CESM	Compact Edge Switch-Managed
CFR	Code of Federal Regulations
CIF	Common Intermediate Format
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CLI	Command Line Interface
CLID	Calling Line Identification
CMAS	California Multiple Award Schedule
CMC	California Mechanical Code
CNG	Comfort Noise Generation
CNID	Calling Party Name Identification
CQC	California Quality Control (CMA Standards)
Codec	Coder/Decoder
COS	Class of Service
CPC	California Plumbing Code
CRA	California Redwood Association
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards, U.S. Department of Commerce
CS	Communications Server
CSFM	California State Fire Marshal
CSI	Construction Specifications Institute
CTIOA	Ceramic Tile Institute of America
CTI	Cooling Tower Institute
DHCP	Dynamic Host Configuration Protocol
DHI	Door and Hardware Institute
DNS	Domain Name System
DSA	Division of the State Architect
DTV	Digital Television
DSS	Direct Station Selection
DTMF	Dual Tone Multiple Frequency
DVD	Digital Video Disc
EIA	Electronic Industries Alliance
EIS	Electronic Image Stabilization
ESM	Edge Switch-Managed
E&M	Ear and Mouth
FAT	Field Acceptance Testing
FEP	Front End Processor

FEP	Fluorinated Ethylene Propylene
FPS	Frames per Second
FTP	File Transfer Protocol
FXS	Foreign Exchange Station
EPA	Environmental Protection Agency
ETL	ETL Testing Laboratories
FCC	Federal Communication Commission
FDA	Food and Drug Administration
FECC	Far End Camera Control
FM	Factory Mutual
FPS	Frames per Second
FS	Federal Specifications
FXO	Foreign Exchange Office
FXS	Foreign Exchange Station
GA	Gypsum Association
GANNA	Glass Association of North America
GBIC	Gigabit Interface Converter
GUI	Graphical User Interface
GigE	Gigabit Ethernet
HMMA	Hollow Metal Manufacturer's Association
HPVA	Hardwood Plywood & Veneer Association
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol over SSL
HVAC	Heating, Ventilation, and Air Conditioning
IACS	International Annealed Copper Standards
IAMPO	International Association of Plumbing and Mechanical Officials
IC	Intercom
ICBO	International Conference of Building Officials
ICEA	Insulated Cable Engineers Association
ICMP	Internet Control and Message Protocol
ID	Identifier
IDF	Intermediate Distribution Frame
IEEE	Institute of Electrical & Electronic Engineers, Inc.
IEC	International Electro technical Commission
IES	Illuminating Engineering Society
IMI	International Masonry Institute
IOR	Inspector of Record
IP	Internet Protocol

IP Router	Internet Protocol Router
IPVC	Internet Protocol Video Conferencing
IPX	Internetwork Packet Exchange
IRI	Industrial Risk Insurers
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ISA	Industry Standard Architecture
ISDN	Integrated Services Digital Network
ISM	Intermediate Switch-Managed (Fiber Switch)
ISP	Internet Service Provider
ITD	OWNER, Information Technology Division
ITU	International Telecommunication Union
IVR	Interactive Voice Response
JPEG	Joint Photographic Experts Group (image format)
Kbps	Kilobits per Second
LAN	Local Area Network
LCD	Liquid Crystal Display
LDC	Local Distribution - Cabinet
LDF	Local Distribution Frame
LED	Light Emitting Diode
LIU	Light Interconnection Unit
MAC	Media Access Control
MAN	Metropolitan Area Network
MBR	Maximum Bit Rate
MCU	Multipoint Conference Unit
MDF	Main Distribution Frame
MDF-BBS	Main Distribution Frame Backbone Switch
MIB	Management Information Base
MIC	Message Integrity Check
MLD	Multicast Listener Discovery
MLSFA	Metal Lath/Steel Framing Association
MPOE	Main Point of Entry
MPEG	Moving Picture Experts Group
MP-BGP	Multi-Protocol Border Gateway Protocol
MOS	Mean Opinion Scale
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry.
NAAMM	National Association of Architectural Metal Manufacturers
NAT	Network Address Translation

NAT-PT	NAT Protocol Translation
NAS	Network Attached Storage
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEBB	National Environmental Balancing Bureau
NEBS	Network Equipment Building System
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEC	National Electrical Code
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NIC	Network Interface Card
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NOFMA	National Oak Flooring Manufacturers Association
NPCA	National Paint and Coatings Association
NPDES	National Pollutant Discharge Elimination System
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NTP	Network Time Protocol
NTMA	National Terrazzo & Mosaic Association
NTSC	National Television System Committee
NUSIG	National Uniform Seismic Installation Guidelines
NWMA	National Woodwork Manufacturers Association
OAR	OWNER Authorized Representative
OC-3	Optical Carrier Level-3 (~155 Mbps)
OEHS	Office of Environmental Health and Safety (LAUSD's)
OFNR	Optical Fiber Non-Conductive Riser
OFNP	Optical Fiber Non-Conductive Plenum
OID	Object Identifier
OPX	Off Premise Extension
OSHA	Occupational Safety & Health Administrations
OSI	Open Systems Interconnection
OSPF	Open Shortest Path First
OTDR	Optical Time Domain Reflectometer.

OWAN	OWNER's Wide Area Network
OWNER	Los Angeles Unified School District
PA	Public Address
PABX	Private Auxiliary Branch Exchange
PA/IC	Public Address/Intercommunications
PAL	Phase Alternating Line
PAT	Port Address Translation
PBX	Private Branch Exchange
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PCM	Pulse Code Modulation
PDI	Plumbing and Drainage Institute
PEI	Porcelain Enamel Institute
PHB	Per Hop Behavior (DiffServ)
PIC	PBX Integration Card
PIM	Protocol-Independent Multicast
PING	Packet Internet Groper
PINX	Private Integrated Services Network Exchange
PIP	Picture in Picture
PMO	Project Management Office
PoE	Power-over-Ethernet
POP	Point of Presence
POTS	Plain Old Telephone System
PRI	Primary Rate Interface
PS	Product Standard, U.S. Department of Commerce
PSIP	Program and System Information Protocol
PSTN	Public Switched Telephone Network
PZM	Pressure Zone Microphone
QCIF	Quarter CIF – See CIF
QoS	Quality of Service
QSIG	Q-Signaling
RADIUS	Remote Access Dial-In User Service
RIP	Routing Information Protocol
RIPng	Routing Information Protocol Next Generation
RIS	Redwood Inspection Service
RMON	Remote Network Monitoring

RMON2	Remote Network Monitoring Version 2
SAN	Storage Area Network
SCAQMD	South Coast Air Quality Management District
SCSI	Small Computer System Interface
SDEI	Steel Deck Institute
SDI	Steel Door Institute
SFM	State Fire Marshal
SFP	Small Form-factor Pluggable transceiver
SFP+	Enhanced Small Form-factor Pluggable transceiver
SFPA	Southern Forest Products Association
SIF	Source input format (NTSC)
SIP	Session Initiation Protocol
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SLC	Small Learning Community
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SMDI	Simple Message Desk Interface
SMI	Structure of Management Information
SMTP	Simple Mail Transfer Protocol
SMPTE	Society of Motion Picture and Television Engineers
SNA	Systems Network Architecture
SNMP	Simple Network Management Protocol
SSH	Secure Shell
SSID	Service Set Identifier
SSL	Secure Socket Layer
SSPC	Steel Structures Painting Council
S/P DIF	Sony/Philips Digital InterFace
SWI	Steel Window Institute
TEHO	Tail End Hop Off
TCA	Tile Council of America
TCP	Transmission Control Protocol
TFTP	Trivial File Transfer Protocol
TIA	Telecommunications Industry Association
TKIP	Temporal Key Integrity Protocol
TLS	Transport Layer Security
TOS	Type of Service
UBPPA	Uni-Bell PVC Pipe Association

UCI	Uniform Construction Index
UFAS	Uniform Federal Accessibility Standards
UL	Underwriters' Laboratories, Inc.
UM	Unified Messaging
UPS	Uninterruptible Power Supply
UPnP	Universal Plug and Play
URL	Uniform Resource Locator
USDA	United State Department of Agriculture
UTC	Coordinated Universal Time
UTP	Unshielded Twisted Pair
VAD	Voice Activity Detection
VBR	Variable Bit Rate
VLAN	Virtual Local Area Network
VM	Voice Mail
VMS	Video Management System
VoD	Video on Demand
VoIP	Voice over Internet Protocol
VFD	Vacuum Fluorescent Display
VTC	Video Teleconference
WAN	Wide Area Network
WLAN	Wireless Local Area Network
WDR	Wide dynamic range
WCLIB	West Coast Lumber Inspection Bureau
WDMA	Window and Door Manufacturers Association
WWPA	Western Wood Products Association

END OF SECTION

SECTION 01 4523  
TESTING AND INSPECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Testing and inspection services to meet requirements of the California Building Code (CBC) and the Division of the State Architect (DSA).
- B. Related Requirements:
  - 1. Section 03 2000 – Concrete Reinforcing.
  - 2. Section 03 3000 – Cast-in-Place Concrete.
  - 3. Section 04 2200 – Concrete Unit Masonry.
  - 4. Section 06 1000 – Rough Carpentry.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
  - 1. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.
- B. American Institute of Steel Construction (AISC):
  - 1. AISC 360 – Specification for Structural Steel Buildings.
  - 2. AISC 341 – Seismic Provisions for Structural Steel Buildings.
- C. ASTM International (ASTM):
  - 1. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
  - 2. ASTM A370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
  - 3. ASTM A706 – Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

4. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  5. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
  6. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
  7. ASTM C1140 - Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels.
  8. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
  9. ASTM C1604 - Standard Test Method for Obtaining and Testing Drilled Cores of Shotcrete.
  10. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments.
  11. ASTM E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
  12. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing.
  13. ASTM E605 - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
  14. ASTM E1444 - Standard Practice for Magnetic Particle Testing.
  15. ASTM F606 - Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets.
- D. Association of the Wall and Ceiling Industry (AWCI):
1. AWCI Technical Manual 12-B - Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide.
- E. American Welding Society (AWS):
1. AWS D1.1 – Structural Welding Code.
  2. AWS D1.4 – Structural Welding Code – Reinforcing Steel.

3. AWS D1.8 – Structural Welding Code – Seismic Supplement.
- F. Division of the State Architect (DSA) Interpretation Regulations (IR):
1. DSA IR 17-2 – Nondestructive Testing (N.D.T.) of Welds.
  2. DSA IR 17-3 – Structural Welding Inspection.
  3. DSA IR 17-8 – Sampling and Testing of High Strength Bolts, Nuts and Washers.
  4. DSA IR 17-9 – High Strength Bolting Inspection.
  5. DSA IR 17-10 – Sampling, Testing and Tagging of Reinforcing Bars.
  6. DSA IR 17-11 – Identification, Sampling and Testing of Threaded Steel Anchor Bolts and Anchor Rods.
  7. DSA IR 22-3 – Open Web Steel Joists and Joist Girders.
  8. DSA IR 23-4 – Metal-Plate-Connected Wood Trusses.
  9. DSA IR-23-8 – Manufactured Wood-Chord-Metal-Web Trusses.

#### 1.03 REGULATORY REQUIREMENTS

- A. Laboratories performing testing shall have DSA's Laboratory Evaluation and Acceptance Program approval prior to providing material testing or special inspection services.
- B. Tests of materials and inspections shall be in accordance to Section 4-213 through 4-219 of the California Building Standards Commission's, California Administrative Code.
- C. Required material testing, inspections and special inspections are indicated on the DSA approved DSA-103, Listing of Structural Tests & Special Inspections (T&I List). OAR will provide CONTRACTOR copy of DSA-103.

#### 1.04 TESTS

- A. OWNER will contract with a DSA approved testing laboratory to perform the testing indicated on the Contract Documents, including the Tests and Special Inspections (T&I) list.
- B. Selection of material to be tested shall be by the Testing Laboratory and not by CONTRACTOR.

- C. Any material shipped from the source of supply prior to having satisfactorily passed such testing and inspection, or prior to the receipt of notice from Project Inspector such testing and inspection is not required, shall not be incorporated into the Work.
- D. OWNER will select, and directly reimburse, the Testing Laboratory for costs of all DSA required tests and inspections; however, the Testing Laboratory may be reimbursed by CONTRACTOR for such costs as specified or noted in related sections of the Contract Documents.
- E. The Testing Laboratory is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
- F. The Testing Laboratory shall not perform any duties of CONTRACTOR.
- G. CONTRACTOR shall provide an insulated curing box with the capacity for twenty concrete cylinders and will relocate said box and cylinders as rapidly as required in order to provide for progress of the Work.

#### 1.05 TEST REPORTS

- A. Test reports shall include all tests performed, regardless of whether such tests indicate the material is satisfactory or unsatisfactory. Samples taken but not tested shall also be reported. Records of special sampling operations, when and as required, shall also be reported. Reports shall indicate the material (or materials) was sampled and tested in accordance with requirements of CBC, Title 24, Parts 1 and 2, as indicated on the Contract Documents. Test reports shall indicate specified design strength and specifically state whether or not the material (or materials) tested comply with the specified requirements.

#### 1.06 VERIFICATION OF TEST REPORTS

- A. Each Testing Laboratory shall submit to the Division of the State Architect, in duplicate, a verified report covering all tests required to be performed by that agency during the progress of the Work. Such report, covering all required tests, shall be furnished prior to Substantial Completion and/or, when construction on the Work is suspended, covering all tests up to the time of Work suspension.

#### 1.07 INSPECTION BY OWNER

- A. OWNER, and its representatives, shall have access, for purposes of inspection, at all times to all parts of the Work and to all shops wherein the Work is in preparation. CONTRACTOR shall, at all times, maintain proper facilities and provide safe access for such inspection.

- B. OAR shall have the right to reject materials and/or workmanship deemed defective Work and to require correction. Defective workmanship shall be corrected in a satisfactory manner and defective materials shall be removed from the premises and legally disposed of without charge to OWNER. If CONTRACTOR does not correct such defective Work within a reasonable time, fixed by written notice and in accordance with the terms and conditions of the Contract Documents, OWNER may correct such defective Work and proceed in accordance with related Articles of the Contract Documents.
- C. CONTRACTOR is responsible for compliance to all applicable local, state, and federal regulations regarding codes, regulations, ordinances, restrictions, and requirements.

#### 1.08 PROJECT INSPECTOR

- A. A Project Inspector will be employed by OWNER in accordance with requirements of Title 24 of the California Code of Regulations with their duties specifically defined therein. Additional DSA Special Inspectors may be employed and assigned to the Work by OWNER in accordance with the requirements of the CBC and DSA.
- B. Inspection of Work shall not relieve CONTRACTOR from any obligation to fulfill all terms and conditions of the Contract Documents.
- C. CONTRACTOR shall be responsible for scheduling times of inspection, tests, sample taking, and similar activities of the Work.

#### 1.09 STRUCTURAL TESTS AND SPECIAL INSPECTIONS

- A. Soils:
  - 1. General: Periodic inspection by Geotechnical Engineer for verification of the following construction activities in conformance to CBC Table 1705A.6:
    - a. Site has been prepared properly prior to placement of controlled fill and/or excavations for foundations.
    - b. Foundation excavations are extended to proper depth and have reached proper material.
    - c. Materials below footings are adequate to achieve the design bearing capacity.

2. Compacted Fills: Testing and inspections shall be in conformance to Table 1705A.6:
  - a. Geotechnical Engineer will continuously verify the use of proper materials and inspect lift thicknesses, placement, and compaction during placement of fill.
  - b. Testing Laboratory under the supervision of the Geotechnical Engineer will:
    - 1) Perform qualification testing of fill materials.
    - 2) Test the compaction of fill.
3. ~~Driven Deep Foundations (Piles): Testing and inspections shall be in conformance to Table 1705A.7:~~
  - a. ~~Continuous inspections by Geotechnical Engineer:~~
    - 1) ~~Verify pile materials, sizes and lengths comply with the requirements.~~
    - 2) ~~Inspect driving operations and maintain complete and accurate records for each pile.~~
    - 3) ~~Verify locations of piles and their plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and record any pile damage.~~
  - b. ~~Testing Laboratory under the supervision of the Geotechnical Engineer will determine capacities of test piles and conduct additional load tests as required.~~
  - c. ~~Steel piles: Tests and inspections will be as indicated on paragraphs below for structural steel.~~
  - d. ~~Concrete piles and concrete filled piles: Tests and inspections will be as indicated on paragraphs below for concrete.~~
4. ~~Cast in place Deep Foundations (Piers): Continuous inspections by Geotechnical Engineer in conformance to Table 1705A.8:~~
  - a. ~~Inspect drilling operations and maintain complete and accurate records for each pier.~~

- b. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, and embedment into bedrock (if applicable). Record concrete or grout volumes.
- c. Confirm adequate end strata bearing capacity.
- d. Concrete Piers: Tests and inspections will be as indicated on paragraphs below for concrete.

5. Retaining Walls:

- a. Continuous inspections by Geotechnical Engineer:
  - 1) Placement, compaction and inspection of soil per CBC Section 1705A.6.1 for fills supporting foundations.
  - 2) Segmental retaining walls; inspect placement of units, dowels, connectors, etc.
- b. Concrete Retaining Walls: Provide tests and inspections as indicated on paragraphs below for concrete.
- c. Masonry Retaining Walls: Provide tests and inspections as indicated on paragraphs below for masonry.

B. Concrete:

- 1. Cast in Place Concrete: Inspection and testing in conformance to CBC Table 1705A.3:
  - a. Inspection of reinforcement, including prestressing tendons and verification of placement, per ACI 318, sections 25.2, 25.2, 25.5.1 through 26.5.3.
  - b. Reinforcing bar welding: Inspect per AWS D1.4, ACI 318 26.5.4.
    - 1) Verification of weldability of reinforcing bars other than ASTM A706.
    - 2) Inspect single-pass fillet welds, maximum 5/16".
    - 3) Inspect all other welds.
  - c. Inspect anchors cast in concrete per ACI 318, section 17.8.2.
  - d. Inspect anchors post-installed in hardened concrete members:

1) Continuous inspection of adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads, per ACI 318, section 17.8.2.4.

2) Mechanical anchors and adhesive anchors, not defined in previous paragraph, per ACI 318, section 17.8.2.

e. Design Mix:

1) Verify use of required mix, per ACI 318, chapter 19 and sections 26.4.3 and 26.4.4.

2) Batch Plant Inspection: The quality and quantity of materials used in transit-mixed concrete and in batched aggregates shall be continuously inspected as required by CBC section 1705A.3.2. If approved by DSA, batch plant inspection may be reduced to periodic if plant complies with CBC section 1705A3.3.1, item 1, and requires first batch inspection, weightmaster, and batch tickets.

f. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete, per ASTM C172, ASTM C31, ACI 318, sections 26.4.5 and 26.12.

g. Inspect concrete and shotcrete placement for proper application techniques, per ACI 318, section 26.4.5.

h. Verify maintenance of specified curing temperature and techniques per ACI 318 sections 26.4.7 through 26.4.9 and CBC section 1908.9.

i. Inspect prestressed concrete for:

1) Application of prestressing forces, per ACI 318 section 26.9.2.1

2) Grouting of bonded prestressing tendons per ACI 318 section 26.9.2.3.

j. Inspection of erection of precast concrete members per ACI 318 chapter 26.8.

k. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs per ACI 318 section 26.10.1.b.

06/12/2017

TESTING AND INSPECTION

01 4523-8

1. Sampling and testing of reinforcing steel per ASTM A370, DSA IR 17-10 and CBC section 1910A.2. CONTRACTOR shall submit mill certificate indicating compliance with requirements for reinforcement, anchors, ties, and metal accessories.
2. ~~Prestressed Concrete: In addition to the tests and inspections required for concrete listed above, the following tests and inspections will performed:~~
  - a. ~~Testing Laboratory will test prestressing tendons and anchorages per CBC section 1910A.3 and ASTM A370.~~
  - b. ~~Special Inspector will check the materials, equipment, tensioning procedure and inspect placement of prestressing tendons and construction, per CBC section 1705A.3.4.~~
  - c. ~~Special Inspector will verify in situ adequate concrete strength prior to stressing tendons.~~
  - d. ~~Continuous inspection by Special Inspector of application of prestressing forces and grouting of bonded prestressing tendons, per CBC section 1705A.3.4.~~
3. ~~Precast Concrete: In addition to the tests and inspections required for concrete listed above, the following tests and inspections will performed:~~
  - a. ~~Continuous inspection by Special Inspector of fabrication of precast concrete members.~~
  - b. ~~Inspection of erection of precast concrete members per ACI 318, chapter 26.8.~~
4. ~~Shotcrete: In addition to the tests and inspections required for concrete listed above, the following tests and inspections will performed:~~
  - a. ~~Continuous inspection by Special Inspector of placement of shotcrete per ACI 318 section 26.4.5.~~
  - b. ~~Testing Laboratory will test strength of shotcrete in accordance to ASTM C1140 and ASTM C1604.~~
5. Post installed Anchors:
  - a. ~~Special Inspector will inspect installation of post installed anchors in hardened concrete members as required by CBC table 1705A.3, item 4.~~

1) Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads, per ACI 318, section 17.8.2.4.

2) Mechanical anchors and adhesive anchors not defined above, per ACI 318, section 17.8.2.

b. Testing Laboratory will test post installed anchors in conformance to CBC section 1905A and ASTM E488.

C. Structural Masonry:

1. Material Verification and Testing:

a. Sampling and testing of reinforcing steel per ASTM A370, DSA IR-17-10 and CBC section 1910A.2. CONTRACTOR shall submit mill certificate indicating compliance with requirements for reinforcement, anchors, ties, and metal accessories.

b. Submit manufacturer's certificate of compliance for masonry units, mortar and grout materials. Test masonry units, mortar and grout (unit strength method).

c. Testing Laboratory will test masonry prisms in conformance with ASTM C1314.

d. Special Inspector will verify proportions of site prepared, premixed or preblended mortar and grout, per ASTM C780.

e. Testing Laboratory will test core drilled samples in conformance with CBC 2114.6.2.

2. Inspection:

a. Special Inspector will continuously inspect preparation of prisms per ASTM C1314.

b. Special inspector will verify size, location and condition of dowels and construction supporting masonry.

c. Special inspector will verify size specified size, grade and type of reinforcement.

d. Special inspector will verify weldability of reinforcing bars other than ASTM A706. Special inspector to inspect reinforcing bar welding: Inspection to be in conformance with AWS D1.4, ACI 318-26.5.4.

06/12/2017

- e. Special inspector will inspect placement of reinforcement, connectors, masonry units and construction of mortar joints.
  - f. Special inspector will verify protection of masonry during cold weather temperature (temperature below 40° F) or hot weather (temperature above 90° F).
  - g. Special inspector will inspect type, size and location of anchors and all other items to be embedded in masonry, including other details of anchorage of masonry to structural members, frames and other construction.
  - h. Special inspector will inspect grout space prior to grouting and placement of grout.
3. Post installed Anchors in Masonry:
- a. Special inspector will inspect anchors cast in concrete per ACI 318, section 17.8.2.
  - b. Special inspector will inspect anchors post installed in hardened concrete members:
    - 1) Continuous inspection of adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads, per ACI 318, section 17.8.2.4.
    - 2) Mechanical anchors and adhesive anchors, not defined in previous paragraph, per ACI 318, section 17.8.2.
  - c. Testing Laboratory will test post installed anchors in conformance to CBC section 1905A and ASTM E488.
- D. Structural Steel:
- 1. Special inspector will verify that all materials are properly marked in conformance with AISC 360, Section 3.3 and applicable ASTM standards.
    - a. Mill certificates indicating material properties that comply with requirements.
    - b. Materials, sizes, types and grades complying with requirements.
  - 2. Testing Laboratory will test unidentified materials in conformance with ASTM A370.

3. Special inspector will examine seam welds of HSS shapes in conformance with DSA IR-17-3.

4. Special inspections and non-destructive testing of structural steel elements shall be in conformance to CBC section 1705A.2.1.

E. High Strength Bolts:

1. Special inspector will verify identification markings and manufacturer's certificates of compliance conform to ASTM standards specified in the Contract Documents, per DSA IR-17-9.

2. Testing Laboratory will test high strength bolts, nuts and washers in conformance with ASTM F606, ASTM A370 and DSA IR-17-8.

3. Special inspector will inspect bearing type ("snug tight") bolt connections in conformance with AISC 360, section M2.5 and DSA IR-17-9.

4. Special inspector will inspect slip critical bolt connections in conformance with AISC 360, section M2.5.

F. Welding:

1. Verification of Materials, Equipment and Welders:

a. Special inspector will verify weld filler material identification markings per AWS designation listed on the Contract Documents and the WPS.

b. Special inspector will verify material manufacturer's certificate of compliance.

c. Special inspector will verify WPS, welder qualifications and equipment in conformance to DSA IR-17-3.

2. Shop Welding: Special inspector will inspect the following, per CBC 1705A.2.1, AISC 360 (and AISC 341, as applicable) and DSA IR-17-3:

a. Groove, multi-pass fillet welds larger than 5/16", plug and slot welds.

b. Single-pass fillet welds equal or less than 5/16".

c. Inspect welding of stairs and railing systems.

d. Verification of reinforcing steel weldability.

06/12/2017

- e. Welding of reinforcing steel, per AWS D1.4.
  3. Field Welding: Special inspector will inspect the following, per CBC 1705A.2.1, AISC 360 (and AISC 341, as applicable) and DSA IR 17-3:
    - a. Groove, multi-pass fillet welds larger than 5/16", plug and slot welds.
    - b. Single-pass fillet welds equal or less than 5/16".
    - c. End welded studs (ASTM A108) installation, including bend test.
    - d. Floor and roof deck welds.
    - e. Welding of structural cold-formed steel.
    - f. Welding of stairs and railing systems.
    - g. Verification of reinforcing steel weldability.
    - h. Inspect welding of reinforcing steel.
  4. Non-Destructive Testing: Testing Laboratory will test perform ultrasonic and magnetic particle testing in conformance to AISC 360 section N5.5, AISC 341 appendix Q5.2, AWS D1.1, AWS D1.8, ASTM E543, ASTM E1444, ASTM E164 and DSA IR 17-2.
- G. ~~Steel Joists and Trusses: Continuous inspection, special inspector will verify size, type and grade for all chord and web members as well as connectors and weld filler material, verify joist profile, dimensions and chamber (if applicable); verify all weld locations, lengths and profiles; mark or tag each joist, in conformance with CBC section 2207.1 and DSA IR 22-3.~~
- H. ~~Fire Proofing:~~
- I. ~~Spray Applied:~~
    - a. ~~Project inspector will examine structural steel surface conditions, inspect application, take samples, measure thickness, and verify compliance of all aspects of application with Construction Documents, in conformance with CBC sections and ASTM E.605.~~
    - b. ~~Testing Laboratory will test bond strength in conformance with ASTM E605, per CBC section 1705A.14.6.~~
    - c. ~~Testing Laboratory will test density in accordance with ASTM E605, per CBC section 1705A.14.5.~~

2. Intumescent Fire Resistant Coatings: Special inspector will inspect and test in accordance with AWCI 12-B, per CBC section 1705A.15.

I. Anchor Bolts, Anchor Rods and Other Steel:

1. Testing Laboratory will sample and test not readily identifiable anchor bolts and anchor rods in accordance with DSA IR 17-11.

2. Testing Laboratory will sample and test not readily identifiable threaded rod not used for foundation anchorage per procedures noted in DSA IR 17-11.

J. Prefabricated Wood Structural Elements:

1. Special inspector will continuously inspect fabrication of glued laminated timber in accordance with CBC section 1704A2.5.

2. Special inspector will continuously inspect fabrication of manufactured open-web trusses in accordance with CBC 1704A2.5 and DSA IR 23-4.

3. Special inspector will continuously inspect fabrication of manufactured metal plate connected trusses in accordance with CBC 1704A2.5 and DSA IR 23-8.

PART 2 – PRODUCTS (Not used).

PART 3 – EXECUTION (Not used).

END OF SECTION

## SECTION 01 5000

## CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

- A. Temporary utilities, construction facilities and temporary controls to be provided, maintained, relocated, and removed by CONTRACTOR.
- B. Temporary office furnishings and office equipment.
- C. Project signage.

## 1.02 QUALITY ASSURANCE

- A. CONTRACTOR shall comply with applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:
  - 1. Building Code requirements.
  - 2. Division of the State Architect.
  - 3. Health and safety regulations.
  - 4. Utility company regulations.
  - 5. Police, fire department and rescue squad requirements.
  - 6. Environmental protection regulations.
- B. CONTRACTOR shall arrange for the inspection and testing of each temporary utility prior to use. Obtain required certifications and permits and transmit to OAR.
- C. CONTRACTOR provided facilities are to be in place and available for OWNER use and occupancy within (Insert Number of Days) calendar days following the date of issue of the Notice to Proceed and shall remain in place and available for OWNER use and occupancy throughout the full term of the Contract.

## 1.03 SUBMITTALS

- A. Temporary Utilities: Submit to OAR reports of tests, inspections, meter readings, certifications, permits and similar procedures performed on temporary utilities.

04/18/2017

INSTALLATION OF 7 RELOCATABLE BUILDINGS

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL

01 5000-1

- B. Project Signage / Banner: Submit to OAR for review and approval.
  - 1. Shop Drawings: Elevation showing the text, OWNER sign and color of project signage, jointing, fittings and location of grommets.
  - 2. Certification: Submit certification attesting fabric is certified as flame retardant, in accordance to NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.04 NOT USED

1.05 NOT USED.

1.06 NOT USED

1.07 NOT USED

1.08 NOT USED

#### 1.09 TEMPORARY STORAGE UNITS

- A. CONTRACTOR shall provide secure and waterproof storage units for the temporary storage of furniture, equipment and other items requiring protection.
- B. Walls, roof and doors shall be a minimum of 16-gauge steel with floors of 1 inch tongue and groove hardwood or  $\frac{3}{4}$  inch minimum exterior type plywood. The undercarriage shall be designed to accommodate forklift blades 42-inch to 60-inch long. There shall be doublewide swing out lockable doors at one end equipped with waterproof gaskets.
- C. CONTRACTOR shall be responsible for delivery charges and will install the storage unit in an appropriate area.
- D. CONTRACTOR shall remove the storage unit from the Project site when the storage unit is no longer required for the Work or upon Substantial Completion of the Work.
- E. CONTRACTOR shall at their expense and without limitation remove and/ or relocate storage units as rapidly as required in order to provide for progress of the Work.

#### 1.10 TEMPORARY SANITARY FACILITIES

- A. CONTRACTOR shall provide portable chemical toilet facilities. Quantity of portable chemical toilet facilities shall be based on total number of workers and shall be in accordance with CAL/OSHA standards.
- B. Portable chemical toilet facilities shall be maintained with adequate supplies and in a clean and sanitary condition and shall be removed from the Project site upon Substantial Completion of the Work. CONTRACTOR shall keep both OWNER chemical toilet facilities and OWNER trailer restroom clean and operational at all times.
- C. CONTRACTOR employees shall not use school toilet facilities.
- D. At CONTRACTOR'S expense and without limitation remove and/or relocate portable chemical toilet facilities as rapidly as required in order to provide for progress of the Work.
- E. CONTRACTOR will contain their breaks and lunch periods to the areas designated by OAR or any public area outside the Project site. CONTRACTOR shall provide a suitable container within the break/lunch area for the placement of trash. Areas used for break/lunch must be maintained clean and orderly. Once finish flooring has been installed in a particular area, no food or beverages will be permitted in that area.

## 1.11

## TEMPORARY SECURITY FENCE / BARRICADE

- A. CONTRACTOR shall install temporary Project site security barricade(s) indicated on Drawings or as required for safety and as specified herein. New or used material may be furnished. Security of Project site and contents is a continuous obligation of CONTRACTOR.
- B. Unless otherwise indicated or specified, security fence shall be constructed of 8-foot high chain link fencing with an 8-foot high windscreen. Space posts not to exceed ten feet on centers. Posts shall be of following nominal pipe dimensions: terminal, corner, and gatepost 2 ½-inch, line posts 2-inch. Chain link fence shall be not less than #13 gauge, 2-inch mesh, and in one width. Posts, fence and accessories shall be galvanized and as follows:
  - 1. Shall be set in the earth a depth of 24-inch with soil firmly compacted around post, unless required otherwise in writing by OAR.
  - 2. Fence fabric shall be attached to posts with #14 gauge tie wire at 16 inches on center. A #6 gauge steel tension wire with turnbuckles shall be installed at top and bottom of barricade fencing. Wire tie fabric to tension wires at 18" centers.

04/18/2017

3. Windscreen shall be attached to fence fabric and steel tension wires at 18-inch centers with a minimum of #14 gauge tie wire. Windscreen shall be maintained and all rips, tears, missing sections shall be corrected upon notification by OAR.
4. Chain link fencing shall be free from barbs, icicles or other projections resulting from galvanizing process. Fence having such defects will be replaced even if it has been installed.
5. Gates shall be fabricated of steel pipe with welded corners, and bracing as required. Fence and fabric to be attached to frame at 12-inch centers. Provide all gate hardware of a strength and quality to perform satisfactorily until barricade is removed upon Substantial Completion of the Work. Each gate shall have a chain and padlock. Provide two gate keys to OAR. At Substantial Completion of the Work, remove barricade from Project site, backfill and compact fence footing holes. Existing surface paving that is cut into or removed shall be patched and sealed to match surrounding areas.
6. At CONTRACTOR'S expense and without limitation remove or relocate fencing, fabric and barricades or other security and protection facilities as rapidly as required in order to provide for progress of the Work.

## 1.12

## OTHER TEMPORARY ENCLOSUREA AND BARRICADES

- A. Provide lockable, temporary weather-tight enclosures at openings in exterior walls to create acceptable working conditions, to allow for temporary heating and for security.
- B. Provide protective barriers around trees, plants and other improvements designated to remain.
- C. Temporary partitions shall be installed at all openings where additions connect to existing buildings, and where to protect areas, spaces, property, personnel, students and faculty and to separate and control dust, debris, noise, access, sight, fire areas, safety and security. Temporary partitions shall be as designated on the Drawings or as specified by ARCHITECT. At CONTRACTOR'S expense and without limitation remove and/or relocate enclosures, barriers and temporary partitions as rapidly as required in order to provide for progress of the Work.
- D. Since the Work of this Project may be immediately adjacent to existing occupied structures and vehicular and pedestrian right of ways, CONTRACTOR shall, in his sole judgment and in accordance with applicable safety standards, provide temporary facilities, additional barricades, protection and care to protect existing structures, occupants, property, pedestrians and vehicular traffic. CONTRACTOR

04/18/2017

is responsible for any damage, which may occur to the property and occupants of the property of OWNER or adjacent private or public properties which in any way results from the acts or neglect of CONTRACTOR.

- E. CONTRACTOR shall be responsible for cleaning up all areas adjacent to the construction site which have been affected by the construction; and for restoring them to at least their original condition- including landscaping; planting of trees, sod, and shrubs damaged by construction; and raking and disposal of debris such as roofing shingles, paper, nails, glass sheet metal, bricks, and waste concrete. Construction debris shall be removed and properly disposed of. Culverts and drainage ditches with sediment from the construction area shall be cleared routinely to maintain proper drainage and re-cleaned prior to completion of the contract.
- F. CONTRACTOR shall ensure sediment does not block storm drains. CONTRACTOR shall be responsible for cleaning storm drains blocked due to erosion or sediment from the work area.

#### 1.13 TEMPORARY STORAGE YARDS

- A. CONTRACTOR shall fence and maintain storage yards in an orderly manner.
- B. Provide storage units for materials that cannot be stored outside.
- C. At CONTRACTOR'S expense and without limitation remove and/or relocate storage yards and units as rapidly as required in order to provide for progress of the Work.

#### 1.14 TEMPORARY DE-WATERING FACILITIES AND DRAINAGE

- A. For temporary drainage and de-watering facilities and operations not directly associated with construction activities included under individual sections, comply with de-watering requirements of applicable Division 01 sections. CONTRACTOR shall maintain the Work, Project site and related areas free of water.
- B. For temporary drainage and de-watering facilities and operations directly associated with new buildings, additions or other construction activities, comply with Divisions 01 and 33 Sections. CONTRACTOR shall be responsible for, but not limited to, de-watering of excavations, trenches and below grade areas of buildings, structures, the Project site and related areas.

#### 1.15 TEMPORARY PROTECTION FACILITIES INSTALLATION

- A. CONTRACTOR shall not change over from using temporary facilities and controls to permanent facilities until Substantial Completion, except as permitted by OAR.
- B. Until permanent fire protection needs are supplied and approved by authorities having jurisdiction, CONTRACTOR shall provide, install and maintain temporary fire protection facilities of the types needed in order to adequately protect against fire loss. CONTRACTOR shall adequately supervise welding operations, combustion type temporary heating and similar sources of fire ignition.
- C. CONTRACTOR shall provide, install and maintain substantial temporary enclosures of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft and similar violations of security. Where materials, tools and equipment are stored within the Work area, CONTRACTOR shall provide secure lock up to protect against vandalism, theft and similar violations of security. OWNER accepts no financial responsibility for loss, damage, vandalism or theft.
- D. CONTRACTOR operations shall not block, hinder, impede or otherwise inhibit the use of required exits and/or emergency exits to the public way, except as approved by OAR. CONTRACTOR shall maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways and other access routes for firefighting equipment and/or personnel.
- E. With approval of OAR and at the earliest feasible date in each area of the Work, complete installation of the permanent fire protection facilities including connected services and place into operation and use. Instruct OWNER personnel in use of permanent fire protection facilities.
- F. In the event of an emergency drill or an actual emergency, designated by the sounding of the fire alarm and/or other sounding device, all construction activities must cease. CONTRACTOR shall evacuate the Work area and remain outside the Work area until permitted to return. No Work shall be conducted during the evacuation of a building or during an emergency.

## 1.16

## TEMPORARY SECURITY AND SAFETY MEASURES

- A. During performance of the Work in existing facilities and/or on a Project Site occupied by students, CONTRACTOR shall provide, install and maintain substantial temporary barriers and/or partitions separating all Work areas from areas occupied by students, faculty and/or administrative staff.
- B. During performance of the Work in existing facilities or on a Project site occupied by students and where temporary barriers or partitions are not physically feasible, CONTRACTOR shall provide an employee meeting the requirements of Education Code Section 45125.2.(2) to continually supervise and monitor all employees of

04/18/2017

CONTRACTOR and Subcontractor. For the purposes of this Section, CONTRACTOR employee shall be someone whom the Department of Justice has ascertained has not been convicted of a violent or serious felony as listed in Penal Code Section 667.5(c) and/or Penal Code Section 1192.7(c). To comply with this Section, CONTRACTOR shall have his employee submit his or her fingerprints to the Department of Justice pursuant to Education Code Section 45125.1(a).

- C. Penal Code Sections 290 and 290.4 commonly known as "Megan's Law", require, among other things, individuals convicted of sexually oriented crimes, to register with the chief of police where the convicted individual resides or with a county sheriff or other law enforcement officials. CONTRACTOR shall check its own employees and require each Subcontractor to check its employees and report to CONTRACTOR if any such employees are registered sex offenders. CONTRACTOR shall check monthly during the life of the Contract to ascertain this information and report same to OAR. Before starting the Work, and monthly thereafter during the life of Contract, CONTRACTOR shall notify OWNER in writing if any of its employees and/or if any Subcontractor's employees is a registered sex offender. If so, CONTRACTOR shall proceed in accordance with paragraph B above.
- D. CONTRACTOR shall employ and maintain sufficient security and safety measures to effectively prevent vandalism, vagrancy, theft, arson, and all other such negative impacts to the Work. Any impacts to the progress of the Work of CONTRACTOR, OWNER, or OWNER'S forces, due to loss from inadequate security, will be the responsibility of CONTRACTOR.
- E. Until Substantial Completion of the Work, CONTRACTOR shall employ appropriate means to remove all graffiti from buildings, equipment, fences and all other temporary and/or permanent improvements on the Project site within twenty-four (24) hours from the date of report or forty-eight (48) hours of each occurrence.

## 1.17

## TEMPORARY ACCESS ROADS AND STAGING AREAS

- A. Due to the limited amount of on and off Project site space for the parking of staff and school visitor's vehicles there will be no parking of CONTRACTOR vehicles in areas designated for school use only. CONTRACTOR shall provide legal access to and maintain CONTRACTOR designated areas for the legal parking, loading, off-loading and delivery of all vehicles associated with the Work. CONTRACTOR shall be solely responsible for providing and maintaining these requirements whether on or off the Project site. CONTRACTOR shall provide and maintain ample on-site parking spaces designated for the exclusive use of OWNER. CONTRACTOR shall erect signs as required by OWNER each of these spaces and prevent all unauthorized vehicles from parking in the OWNER-reserved spaces.

04/18/2017

- B. Temporary access roads are to be installed and maintained by CONTRACTOR to all areas of the Project site.
- C. CONTRACTOR will be permitted to utilize existing facility campus roads as designated by OAR. CONTRACTOR shall only utilize those entrances and exits as designated by OAR and CONTRACTOR shall observe all traffic regulations of OWNER.
- D. CONTRACTOR shall maintain roads and walkways in a clean condition including removal of debris and/or other deleterious material on a daily basis.

1.18 DIRECTIONAL SIGNAGE AND ADVERTISEMENT POSTING

- A. CONTRACTOR shall provide and install signage to provide directional, identification, and contact information to construction personnel and visitors as follows and as reviewed by OAR.
  - 1. For construction traffic control/flow at entrances/exits, and as designated by OAR.
  - 2. To direct visitors.
  - 3. For construction parking.
  - 4. To direct deliveries.
  - 5. For Warning Signs as required.
  - 6. In accordance with CAL/OSHA standards as necessary.
  - 7. For trailer identification and Project site address.
  - 8. For "No Smoking" safe work site at designated locations.
  - 9. Emergency contact information and phone number of CONTRACTOR.
  - 10. Emergency contact information and phone number of local police, fire, and emergency personnel.
  - 11. For Labor Compliance Program (LCP) as required under the General Conditions (Prevailing wage rates and Notice of LCP)
  - 12. Employee benefits payments paid to trust funds are required under the General Conditions.

04/18/2017

INSTALLATION OF 7 RELOCATABLE BUILDINGS

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL

01 5000-8

- B. OWNER has established a program authorizing vendors to post advertisements and billboards along the perimeter of project site. CONTRACTOR shall provide access and shall allow advertising signage to be placed on top of temporary, perimeter, security barricade and/or fences.

1.19 TRENCHES

- A. Open trenches for installation of utility lines (water, gas, electrical and similar utilities) and open pits outside barricaded working areas shall be barricaded at all times in a legal manner determined by CONTRACTOR. Trenches shall be backfilled and patch-paved within twenty-four (24) hours after approval of installation by authorities having jurisdiction or shall have "trench plates" installed. Required access to buildings shall be provided and maintained. CONTRACTOR shall comply with all applicable statutes, codes and regulations regarding trenching and trenching operations. Open trenches deeper than 3'-6", and not located within a public street access, shall be enclosed within an 8'-0" high chain-link fence.

1.20 DUST CONTROL

- A. CONTRACTOR is responsible for dust control on and off the Project site. When Work operations produce dust the Project site and/or streets shall be sprinkled with water to minimize the generation of dust. CONTRACTOR shall clean all soils and debris from construction vehicles and cover both earth and debris loads prior to leaving the Project site. CONTRACTOR shall, on a daily basis, clean all streets and/or public improvements within the right of way of any and all debris, dirt, mud and/or other materials attributable to operations of CONTRACTOR.

1.21 WASH OUT

- A. CONTRACTOR shall provide and maintain a minimum of four (4) wash out boxes of sufficient size and strength to provide for concrete mixer wash out. CONTRACTOR shall locate and relocate both the wash out boxes and wash out areas in order to accommodate the progression of the Work. The wash out area shall be located as to minimize the amount of potential run off onto adjacent private and/or public property. CONTRACTOR shall legally dispose of the contents of the wash out boxes and area on an as needed basis or as required by OAR.

1.22 WASTE DISPOSAL

- A. CONTRACTOR shall provide and maintain trash bins on the Project site. Trash bins shall be serviced on an as needed basis and CONTRACTOR is responsible for the transportation of and the legal disposal of all contents.

04/18/2017

## 1.23 ADVERSE WEATHER CONDITIONS

- A. Should warnings of adverse weather conditions such as heavy rain and/or high winds be forecasted, CONTRACTOR shall provide every practical precaution to prevent damage to the Work, Project site and adjacent property. CONTRACTOR precautions shall include, but not be limited to, enclosing all openings, removing and/or securing loose materials, tools, equipment and scaffolding.
- B. CONTRACTOR shall provide and maintain drainage away from buildings and structures.
- C. CONTRACTOR shall implement all required storm water mitigation measures as required under related Division 01 Sections.

## 1.24 DAILY AND MONTHLY REPORTS

- A. CONTRACTOR shall provide and maintain in the Project site office of CONTRACTOR, a daily sign in sheet for use by all employees of CONTRACTOR and all Subcontractors at whatever tier. At the beginning of each work day, the foreman, project manager, superintendent of CONTRACTOR and/or Subcontractors shall visit the site office of CONTRACTOR and shall enter onto the daily sign in sheet: all employee names; trade classification; and represented company. The completed sign in sheet shall serve as the basis of and shall be submitted with the daily construction report as set forth in Paragraph B below.
- B. By the end of each workday, CONTRACTOR shall submit to OAR and INSPECTOR a daily construction report denoting the daily manpower counts and a brief description/location of the workday activities. Manpower shall be broken down by trade classification such as foreman, journeyman or apprentice. The report shall also note the date, day of the week, weather conditions, deliveries, equipment on the Project site whether active and/or idle, visitors, inspections, accidents and unusual events, meetings, stoppages, losses, delays, shortages, strikes, orders and requests of governing agencies, Construction Directive and/or Change Orders received and implemented, services disconnected and/or connected, equipment start up or tests and partial use and/or occupancies. CONTRACTOR shall also include on the daily construction report the above information for all Subcontractors at whatever tier.
- C. CONTRACTOR shall submit on a monthly basis the forms found in Sections 01 3239 and 01 7416 certifying CEQA Mitigations and Storm Water Pollution Prevention (SWPP) compliances.

## 1.25 NOT USED

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PART 2 – PRODUCTS – Not Used

PART 3 – EXCLUSION – Not Used

END OF SECTION

INSTALLATION OF 7 RELOCATABLE BUILDINGS

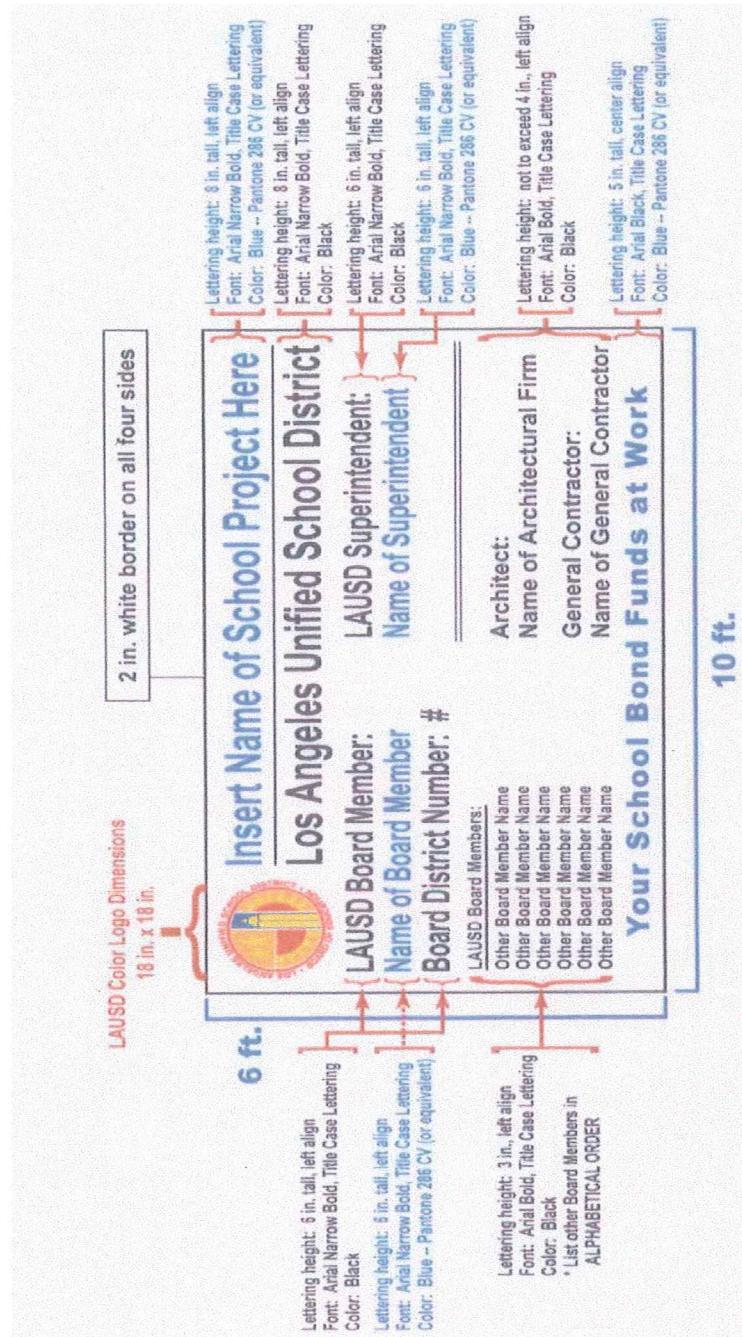
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

BIRMINGHAM COMMUNITY CHARTER HIGH SCHOOL

04/18/2017

01 5000-11

## APPENDIX A



END OF APPENDIX A

## SECTION 04 2200

## CONCRETE UNIT MASONRY

## PART 1 - GENERAL

## 1.01 SUMMARY

## A. Section Includes:

1. Concrete masonry units.
2. Reinforcing steel.
3. Mortar, grout and grouting.
4. Bolts, anchors, hardware, metal frames, and other insert items.

## B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 4523 - Testing and Inspection.
3. Section 03 1000 - Concrete Forming and Accessories.
4. Section 03 2000 - Concrete Reinforcing.
5. Section 03 3000 - Cast-In-Place Concrete.

## 1.02 REFERENCES

## A. American Society for Testing and Materials International (ASTM):

1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
2. ASTM C90 - Standard Specification for Load Bearing Concrete Masonry Units.
3. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
4. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
5. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
6. ASTM C150 - Standard Specification for Portland Cement.

7. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
  8. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
  9. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
  10. ASTM C426 - Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.
  11. ASTM C476 - Standard Specification for Grout for Masonry.
  12. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
  13. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
  14. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
  15. ASTM C1586 – Standard Guide for Quality Assurance of Mortars.
- B. Masonry Standards Joint Committee (MSJC), the Masonry Society (TMS), American Concrete Institute (ACI) and American Society of Civil Engineers (ASCE).
1. TMS 602/ACI 530.1/ASCE 6 – Specification for Masonry Structures.
  2. TMS 402/ACI 530/ASCE 5 – Building Code Requirements for Masonry Structures.

#### 1.03 SUBMITTALS

- A. Mix Design: Submit grout and mortar mix designs. Mix designs shall be signed and sealed by a Civil or Structural Engineer registered in the State of California.
- B. Product Data: Submit manufacturer's Product Data for assembly components, materials, and accessories. Submit certificates and data assuring that the proposed materials meet the specified ASTM standards.
- C. Samples: Submit Samples for each type of required masonry unit, including reinforcement and accessories.
- D. Shop Drawings: Indicate wall reinforcement, splice locations and bending diagrams.
- E. Admixtures: Additives and admixtures to mortar and grout shall not be used unless approved by the enforcing agency. Submit product data for any proposed admixture.

#### 1.04 REGULATORY REQUIREMENTS

- A. Perform the Work in accordance with CBC, Chapter 21A.
- B. Comply with requirements of TMS 602.

1.05      **QUALITY ASSURANCE**

- A. Comply with the requirements of Section 01 4523 - Testing and Inspection.
- B. Concrete Masonry Units:
  - 1. Notify the testing laboratory a minimum of 45 days in advance of installing concrete unit masonry, to allow for preconstruction testing of the units.
    - a. Units will be sampled and tested in accordance with ASTM C140 for compressive strength, absorption and moisture content.
    - b. Units will be sampled and tested in accordance with ASTM C426 for linear drying shrinkage.
  - 2. The material testing laboratory shall receive concrete masonry unit specimens for testing from masonry unit manufacturer. Number of specimens shall be as indicated in referenced ASTM standard tests. Testing laboratory will perform and send test results to the ARCHITECT and Project Inspector.
- C. Portland Cement: Submit certification from the cement manufacturer that the cement proposed for use on the project has been manufactured in accordance with ASTM C150. Certification shall include test results made on cement samples during production.
- D. Mortar and Grout Tests: Prior to the beginning of masonry work, mortar and grout will be tested, unless prism tests will be performed as indicated below.
  - 1. Mortar: Shall conform to ASTM C270 Table 2 for Type S mortar.
    - a. Provide qualifications of mortar as meeting ASTM C270 at the beginning of the job and whenever mix design is changed.
    - b. Mortars will be evaluated during preconstruction and tested during construction for proportioning or compressive strength in accordance to ASTM C780.
  - 2. Grout: Shall conform to ASTM C476, and will be tested in accordance with ASTM C1019. Compressive strength shall equal or exceed specified compressive strength ( $f'm$ ) at 28 days, but not less than 2,000 psi.
    - a. Ready-Mix Grout: Grout manufacturer shall furnish batch ticket information in accordance to ASTM C94.

- E. Prism Test: The compressive strength of concrete masonry will be determined by the prism test method prior to the start of construction and during construction.
- F. Masonry Core Testing: Core testing will be performed in accordance with CBC, Section 2105A.4.
- G. Inspection During Installation: A special inspector will continuously observe the installation of reinforced masonry. The Project Inspector shall be responsible for monitoring the work of the special inspector and testing laboratories to ensure that the testing program is satisfactorily completed.
- H. OWNER will be responsible for the costs of original tests and inspection.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Store units above grade on level platforms or pallets, in a dry location.
- B. Store cementitious materials and aggregates in such a manner as to prevent deterioration or intrusion of foreign matter or moisture.
- C. Handle units on pallets or flat bed barrows. Free discharge from conveyor units or transportation in mortar trays is not permitted.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Concrete Unit Masonry: Modular **normal** weight conforming to ASTM C90, hollow load-bearing concrete unit masonry. Masonry units shall meet the minimum compressive strength requirements of ASTM C90, or as indicated on project drawings, whichever is greater.
  - 1. Concrete masonry unit sizes shall be as indicated on the drawings.
  - 2. Provide open-end units at walls to be fully grouted.
  - 3. Provide closed-end units at walls and at openings where ends will be exposed in finish Work; provide bond beam blocks where horizontal reinforcement is indicated.
  - 4. Provide special shapes and accessory units at locations indicated on Drawings.
  - 5. Provide units in colors and textures as indicated in the drawings.
  - 6. Masonry unit shall have been cured for a minimum of 28 days.

7. Masonry unit shall have maximum liner shrinkage of 0.065 percent from saturated to oven dry.
- B. Portland Cement: ASTM C150, Type II, from one source.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Aggregates: ASTM C144 for mortar and ASTM C404 for grout.
- E. Mortar: ASTM C270, Type S, conforming to the property specifications of CBC Table 2103A.8 (2).
- F. Grout: ASTM C476.
- G. Admixture for Grout: Grout Aid, as manufactured by Sika Chemical Corp., or equal.
- H. Water: Clean, potable, free from substances deleterious to mortar, grout or reinforcement.
- I. Reinforcing Steel: Provide and install reinforcing steel in accordance with Section 03 2000 - Concrete Reinforcing.
- J. Cleaning Materials: Sure Klean No. 600 detergent by ProSoCo.
- K. Miscellaneous Materials: As required to complete the Work.
- L. Anchor Bolts: Shall be hex headed bolts conforming to ASTM A307 Grade A with the dimensions of the hex head conforming to ANSI/ASME B18.2.1.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Discard units with cracks or other defects not complying with requirements of ASTM C 90.

#### 3.02 CONSTRUCTION

- A. Construct per applicable provisions of CBC and TMS 602.
- B. Conform to TMS 602 for hot and cold weather masonry construction.

#### 3.03 MORTAR AND GROUT MIXING

- A. Mortar: Shall provide a minimum strength of 1,800 psi.

- B. Grout: Shall provide a minimum strength of 2,000 psi or as indicated in the drawings, whichever is higher. Grout space requirements for coarse and fine grouts shall be per Table 7 of TMS 602. Add Sika Chemical Corp. Grout Aid per manufacturer's instructions.
- C. Measurements: Measure in calibrated devices that can be checked at any time.
  - 1. Add water for workable consistency.
  - 2. Shovel measurements are not permitted.
- D. Mixing: Mix in accordance to TMS 602.
  - 1. Mortar: Mix cementitious materials and aggregates between three and five minutes in a mechanically operated mixer. Mix dry ingredients with a sufficient amount of water to provide a workable mix. Batches of less than one sack of cement, and fractional sack batches are not permitted.
  - 2. Factory Blended Mortar: Mix in accordance with manufacturer's recommendations.
  - 3. Grout: Add sufficient water for a workable mix that will flow into all voids of the masonry without separation or segregation. Grout slump shall be between 8 and 11 inches.
- E. Re-tempering Time Limit: Use mortar within 2 ½ hours after mixing. Discard any mortar that has been mixed longer or that has begun to set. If necessary re-temper within this time limit, by replacing only water lost due to evaporation and by thoroughly remixing.

## 3.04

## INSTALLATION OF MASONRY UNITS

- A. Workmanship: Install masonry plumb and true to line with straight level joints of uniform thickness. Comply with TMS 602 tolerances. Maintain masonry clean during and after installation.
  - 1. Lay-out and incorporate embedded hardware items.
  - 2. Assist other trades with built-in items, which require cutting and fitting of masonry.
  - 3. Cut block units with a diamond saw or carborundum wheel. Trowel or chisel cutting is not permitted.
  - 4. Keep cavities clear of droppings and debris. Remove droppings prior to grouting.

- B. Reinforcing Steel: Install as indicated on Drawings. Except as otherwise indicated, install reinforcement in accordance with standards of Concrete Reinforcing Steel Institute and to requirements specified in Section 03 2000 - Concrete Reinforcing. Do not splice vertical reinforcement except where indicated on the Drawings.
- C. Shoring: Provide temporary shoring for lintels with sufficient strength to carry load without deflecting. Remove temporary shoring not less than 28 days after masonry has been installed.
- D. Block Installation: Clean dirt and dust from surfaces before installation. Do not wet masonry units.
  - 1. Foundation preparation: Clean top surface of concrete foundation of dirt, projections and laitance before starting masonry construction. Wet saw cutting of units immediately prior to laying is permitted.
  - 2. Install masonry with mortar to required joint thickness. Install blocks with 3/8-inch mortar bed. Fill head joints solid, install tightly to adjoining units. Provide 3/8-inch joint thickness.
    - a. Hold racking to a minimum.
    - b. No toothing is permitted.
    - c. If it becomes necessary to move a unit after it has been installed, remove the unit, discard the mortar, and install the unit in fresh mortar.
  - 3. Anchor Bolts: Provide 1/2-inch minimum grout space between bolts and masonry.
  - 4. Bond: Unless otherwise indicated, install units in common running bond.
  - 5. Finish Joint Treatment: Unless otherwise indicated, cut both interior and exterior joints flush, and tool slightly concave to a dense, uniform surface.
  - 6. Grouting: Unless noted otherwise on Drawings, completely fill cells with grout.

### 3.05 GROUTING

- A. Prior to grouting all cells shall be cleaned so that all spaces to be filled with grout do not contain mortar projections greater than 1/4 inch, loose mortar or foreign material.
- B. Grout materials and water contents shall be controlled to provide adequate fluidity for placement without segregation of the constituents, and shall be mixed thoroughly. Reinforcement shall be properly positioned and solidly embedded in the grout.

- C. The grouting of any section of wall shall be completed in one day with no interruptions greater than one hour.
- D. Between grout pours, a horizontal control joint shall be formed by stopping all wythes at the same elevation and with the grout stopping at 1 ½ inches below a mortar joint, except at the top of the wall. Where bond beams occur, the grout pour shall be stopped a minimum of ½ inch below the top of the masonry.

### 3.06 LOW-LIFT GROUTING FOR HOLLOW MASONRY UNITS

- A. Grouting shall meet the requirements of CBC Section 2104A.1.3.
- B. After mortar joints have set, cells are cleaned of mortar and debris, and reinforcement is installed and inspected, grout cells in 4-foot maximum lifts. Horizontal and vertical reinforcement shall be held in place within permitted tolerances by suitable devices.
- C. Grout may be installed by pump, tremie or bucket, using hoppers to avoid spilling on exposed surfaces.
- D. All grout shall be consolidated and reconsolidated with a mechanical vibrator after placing so as to completely fill all voids and to consolidate the grout. Grouted walls shall be solid and without voids.

### 3.07 HIGH-LIFT GROUTING OPTION FOR HOLLOW MASONRY UNITS

- A. Grouting shall meet the requirements of CBC Section 2104A.1.3 and DSA IR 21-2.
- B. High-lift grouting shall apply only to cell sizes available with 8 inch and wider block units. This method is subject to approval of the Division of the State Architect (DSA).
- C. Provide bond beam units, inverted for start course, and omit alternate blocks or remove entire face shell of every other unit to allow access to all cells on bottom course for cleanouts.
- D. Plug each cleanout by setting a face shell in mortar into opening and securely bracing it in place to prevent displacement. If masonry is not exposed in finish Work, cleanouts may be formed.
- E. Grouting: Grouting shall be done in a continuous pour in lifts not exceeding 5-foot in height. The grouting of any section of a wall between control barriers shall be completed in one day, with no interruptions greater than one hour.
- F. Consolidating: Grout shall be consolidated by mechanical vibration only, and shall be reconsolidated after excess moisture has been absorbed, but before plasticity is lost. Vibrating of reinforcing steel is not permitted.

### 3.08 CURING

- A. Remove efflorescence, stains, debris, excess grout, and foreign matter.
- B. During curing, or for any other purpose, do not saturate masonry with water.

3.09 PARGE COAT

- A. Apply parge coat to the earth side of surfaces that are to receive waterproofing.
- B. A Portland cement and sand mix (1:3.5 by volume) or Type S mortar may be used for the parge coat.
- C. Parging should be applied to damp (not saturated) concrete masonry in two 1/4 inch thick layers. The first coat should be roughened when partially set, hardened for 24 hours, and then moistened before second coat is applied. The second coat should be trowelled to a smooth, dense surface.
- D. The parge coat should be beveled at the top to form a wash, and thickened at the bottom to form a cove between the base of the wall and the top of footing.

3.10 CLEANING

- A. At completion of masonry Work, remove misplaced mortar, grout or other foreign substances, and clean surfaces which will be exposed in finish Work with specified cleaner, or with clean water and stiff fiber brushes.
- B. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.11 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

**SECTION 05 5000**  
**METAL FABRICATIONS**

**PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes: Metal fabrications:
  - 1. Steel pipe.
  - 2. Square and rectangular steel tubing.
  - 3. Pipe columns.
  - 4. Steel stairs.
  - 5. Handrails and guardrails.
  - 6. Steel thresholds.
  - 7. Steel ladders.
  - 8. Steel Gates.
  - 9. Gratings, frames and covers.
  - 10. Miscellaneous fabrications, as indicated on the Drawings.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 01 4523: Testing and Inspection.

**1.02 SUBMITTALS**

- A. Shop Drawings: Submit Shop Drawings indicating provided materials, dimensions, anchoring detail, and details of termination or connection to adjacent construction. Indicate items that are purchased from a manufacturer and items that are shop fabricated. Indicate component parts requiring Project site fabrication or assembly.
- B. Product Data: Submit Product Data for manufactured items. Submit Product Data for primers and finishes.
- C. Material Samples: Submit Samples of primers and finishes on fabricated items.
- D. Installation Instructions: Submit installation instructions for manufactured items.

**1.03 QUALITY ASSURANCE**

- A. Comply with the following as a minimum requirement:
  - 1. Design, fabricate, and install miscellaneous metals in accordance with AISC - Design, Fabrication, and Erection of Structural Steel for Buildings.
  - 2. AWS D-1.1 Code - Welding in Building Construction.
  - 3. Inspection of Welding: Refer to Section 01 4523: Testing and Inspection.
  - 4. Welding: Refer to Section 01 4523 Testing and Inspection.

- B. Coordinate installation of accessory items required for metal fabrications.

#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Store miscellaneous metal items above grade on platforms, skids, or other required supports.
- B. Protect from corrosion or damage.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Structural Steel Shapes: ASTM A36.
- B. Steel Pipe:
  - 1. Steel pipe for pipe columns and other structural purposes shall conform to ASTM A53, Type E or S, Grade B, as required.
  - 2. Steel pipe other than pipe furnished for structural purposes shall conform to ASTM A53.
- C. Square and Rectangular Steel Tubing:
  - 1. Steel tubing for structural purposes shall be carbon steel conforming to ASTM A500 or ASTM A36.
  - 2. Steel tubing other than tubing furnished for structural purposes shall be hot or cold rolled carbon steel electric welded tubing.
- D. Cast Steel: ASTM A27, Grade 65-35.
- E. Steel Bolts: ASTM A307, Grade A, with bolt head and nut dimensions conforming to ANSI B 18.2.1.
- F. Rolled Steel Plates and Shapes:
  - 1. Shapes and plates shall conform to ASTM A36, except for plates to be bent or cold-formed.

2. Plates to be bent or cold-formed shall conform to ASTM A283, Grade C.

G. Chain: Chain shall be 4/0 double loop pattern coil chain.

H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications "Rapid set Cement".

2.02 FABRICATION

A. General:

1. For fabrication of Work exposed to view, provide only materials smooth and free of blemishes. Remove blemishes by grinding or by welding and grinding, before cleaning, treating, and installation of surface finishes including zinc coatings.

2. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated or specified.

B. Stair and Balcony Railings:

1. Railings: Handrails and standards shall be fabricated of Grade B standard weight steel pipe or indicated on Drawings. After fabrication, rails shall be galvanized. Standards shall be attached to stringers and face of balcony as detailed.

2. Panels:

a. Mesh shall be 10 gage 1 ½-inch diamond mesh. The wires shall extend through the channel frame and shall be clinched.

b. Frame members shall be 1 inch by 1/2 inch by 1/8 inch thick plate welded to top and end members. Corners shall be mortised and tenoned and continuously welded together. Panels shall be galvanized. Fasten panels to rails and standards as indicated.

3. Handrail Brackets: Type indicated.

C. Miscellaneous Framing and Supports:

1. Except as otherwise indicated, space anchors 2 feet on center, and provide minimum anchor units of 1 ¼-inch by ¼ inch by 8-inch steel straps.

2. Shelf angles for exterior construction shall be galvanized steel of sizes indicated.

C. Welding:

1. Weld connections unless otherwise indicated.

2. Weld corners and seams continuously and in accordance with requirements of AWS Code. Welds shall be inspected as required in Section 05 1200: Structural Steel Framing.

3. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

D. Galvanizing:

1. ASTM A123, ASTM A153, or ASTM A386, as applicable, hot dip with 2.0 ounces per square foot on actual surface and 1.8 ounces per square foot minimum on any specimen, and as specified herein.

2. Galvanizing Repair Material: DRYGALV as manufactured by the American Solder and Flux Company, Galvalloy, Galvion, or equal. Hot applied repair material, or anodic zinc-rich galvanizing repair paint conforming to Mil Spec DOD-P-21035.

3. Items to be galvanized shall be hot-dip galvanized in sections as large as possible.

E. Shop Finish:

1. Metal fabrications shall be provided with a coat of primer, except those indicated to be completed with exposed galvanized finish.

2. Primers:

a. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

b. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

c. Minimum dry film thickness of primer shall be 2.0 mils.

3. Preparation for Primer Painting: Miscellaneous ferrous metal, except items specified galvanized, shall be thoroughly cleaned and prepared for painting, including removal of shipping oils or protective coatings, mill scale, grease, dirt and rust. Prepare in accordance with SSPC recommendations. Deliver to Project site primed or galvanized as indicated, and ready to receive Project site applied finishes.

4. Galvanized Metal Work to receive Paint: Clean oil, grease and other foreign materials from surfaces. Apply vinyl wash pretreatment coating. Follow manufacturer's instructions for drying time, and then prime with one coat of metal primer.

### PART 3 - EXECUTION

**3.01            INSTALLATION****A. Handrails and Guardrails:**

1. Install standards into metal sleeves cast in concrete, and extending into it at least 9 inches. Wedge standards true, plumb, and fastened by packing with grout. Finish grout smooth and flush with adjacent surfaces.
2. Rails contacting a vertical surface shall be fitted with standard pipe rail flanges, secured to concrete or masonry surfaces with 3/8 inch 2-unit cinch anchor bolts and secured to wood frame surfaces with 3/8 inch lag screws, unless otherwise indicated.
3. Railings abutting pipe columns shall be provided with shaped end caps to fit columns welded to rails, and secured to columns with self-tapping machine screws.

**B. Gratings, Frames and Covers:**

1. Over areas indicated, provide steel gratings and grating frames as detailed. Frames shall have mitered and welded corners, and be fitted with anchors.
2. Provide steel checkered plate covers and steel frames for sumps, grease traps, and sand traps, and other covers for access where indicated. Frames shall be provided with mitered and welded corners and be fitted with anchors as detailed. Cover shall be perforated. Each section of access cover shall be furnished with steel pull rings and tool operated fastening device. Screws to fasten covers shall be brass.

**3.02            ADJUSTING****A. Touch Up Damaged Surfaces:**

1. Shop Painted Finishes: Comply with SSPC-PA-1 for touch-up; apply with brush to produce a minimum 2.0 mil dry film thickness.
2. Galvanized Surfaces: Clean field welds, connections and damaged areas. Repair galvanized finishes in accord with ASTM A780.

**3.03            CLEAN UP****A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.****3.04            PROTECTION****A. Protect the Work of this section until Substantial Completion.**

END OF SECTION

**SECTION 06 1000**  
**ROUGH CARPENTRY**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Rough carpentry Work.
2. Installation of glued laminated members, plywood web joists or wood chord metal web joists.

**B. Related Requirements:**

1. Division 01 - General Requirements.
2. Section 01 4523: Testing and Inspection.
3. Section 03 1000: Concrete Forming and Accessories.
4. Section 03 3000: Cast-In-Place Concrete.
5. Section 06 2000: Finish Carpentry.

**1.02 SYSTEM DESCRIPTION**

**A. Regulatory Requirements:**

1. Work of this Section shall comply with CBC Chapter 23.

**1.03 QUALITY ASSURANCE**

**A. Comply with the following as a minimum requirement:**

1. Redwood structural and framing lumber shall be graded in accordance with Standard Specifications for Grades of California Redwood Lumber of the Redwood Inspection Service.
2. Douglas fir, larch or hemlock structural and framing lumber shall be graded in accordance with the Standard Grading Rules of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Lumber Grading Rules of the Western Wood Products Association (WWPA).

3. Plywood shall conform to requirements of Product Standard PS 1, and shall be grade marked by a recognized grading agency (APA and PTL).
- B. Lumber shall bear official grade mark of the association under whose rules it was graded or official grade mark of another recognized grading agency.
- C. Structural and framing members 2-inch thick (nominal) and larger shall be air-dried to moisture content not to exceed 19 percent before installation.
- D. Each piece of preservative treated lumber shall be identified by the Quality Mark of an approved inspection agency in accordance with CBC Chapter 23; refer to Section 01 4523: Testing and Inspection.
- E. Lumber showing visible signs of mold growth:
  1. Lumber showing visible signs of mold growth shall be removed from the project site or cleaned as outlined below.
  2. The contractor is responsible for all costs associated with cleaning, post-cleaning testing, and reporting for lumber with mold.
    - a. Lumber that shows visible signs of mold growth prior to, or after installation, shall be cleaned pursuant to the current edition of USEPA's guidance publication "Mold Remediation in Schools and Commercial Buildings (EPA 402-K-01-001).
    - b. A minimum of 10 percent of the total locations cleaned must be sampled (tape lift method) post cleaning to ensure cleaning effort was successful. Cleaning will be considered acceptable when tape lift sample results evaluated by direct microscopic examination determine that the general abundance of mold is non-detect or rare (normal trapping to 1+).
    - c. A report prepared by a Certified Industrial Hygienist (CIH) that details the sampling and cleaning results shall be prepared and submitted to the OAR for review and approval of the LAUSD Office of Environmental Health and Safety.
    - d. Cleaned lumber shall not be installed or enclosed by finish materials until approval of test results. Cleaned lumber must meet moisture content requirements as required elsewhere in this specification prior to installation or application of finishes.

## 1.04

## STORAGE, HANDLING AND PROTECTION

- A. The materials supplied as part of the Work of this section shall be protected from exposure to inclement weather before being covered by other Work.

## PART 2 - PRODUCTS

## 2.01 MATERIALS

- A. Lumber: Structural and framing lumber shall be of following species and grades:

	<u>INSTALLATION</u>	<u>SPECIES</u>	<u>GRADE</u>
1.	Subfloor, wall sheathing, roof sheathing and ceiling furring	Douglas fir and larch	Construction Board, WCLIB, WWPA
2.	Posts, (5 inch by 5 inch and larger, width not more than 2 inches greater than thickness).	Douglas fir and larch	No. 1 or better Structural Posts and Timbers, WCLIB. No. 1 or better Post and Timbers, WWPA.
3.	Beams, girders and truss members (5 inch and thicker, rectangular, width more than 2 inches greater than thickness) where exposed as finish members.	Douglas fir and larch	No. 1 or better Structural Beams and Stringers, WCLIB; WWPA.
4.	Joists, rafters, lintels, posts, mullions and members (2 to 4-inch thick, 2 to 4 inch wide)	Douglas fir and larch	No. 1 or better, Structural Light Framing, WCLIB,
5.	Other lumber (2 to 4 inch thick, 2 to 4 inch wide) not specified in subparagraph 5 above	Douglas fir and larch	Construction Light Framing WCLIB, WWPA
6.	Framing lumber (2 to 4-inch thick, 5-inch and wider).	Douglas fir and Larch	No. 1 or better Structural Joists and Planks, WCLIB; WWPA.
7.	Mudsills and plates in contact with earth.	Douglas fir and Larch Treated	Same as subparagraphs 5 and 6.
8.	Sills or plates installed on concrete or masonry surfaces 6 inches or less above earth or finish grade.	Douglas fir and Larch Treated	Same as subparagraphs 5 and 6.
9.	Sills, foundation plates and sleepers installed on concrete, masonry	Douglas fir and Larch	Same as subparagraphs 5 and 6.

- |  |         |
|--|---------|
| foundations, or installed<br>on concrete slab in direct contact<br>with earth. | treated |
|--|---------|
10. Miscellaneous nailing strips and blocks embedded in concrete or masonry.
- |                               |                                |
|-------------------------------|--------------------------------|
| Douglas fir and Larch treated | Same as subparagraphs 5 and 6. |
|-------------------------------|--------------------------------|
- B. Plywood: Plywood furnished for structural purposes, when exposed outdoors, shall be exterior type plywood. Other plywood furnished for structural purposes shall be exterior type, or Exposure 1.
- C. OSB Board or Panels:
1. Oriented strand board or panels shall not be furnished as part of the Work of this section.
- D. Preservative Treated Wood:
1. Wood and plywood specified; as treated wood shall be pressure treated wood in accordance with CBC requirements.
  2. Seasoning: Treated lumber shall be air seasoned after treatment, for a minimum of two weeks before installation. Moisture content shall be 15 percent maximum.
  3. Creosote or arsenic is not permitted for treating wood.
  4. When treated wood member have been notched, dapped, drilled, or cut, such newly cut surfaces shall be painted with a heavy coat of the same preservative material originally provided for treatment of wood member.
- E. Fire Retardant Protection: Wood and plywood specified as fire retardant protected wood shall be treated by approved methods and materials and shall be dried following treatment to maximum moisture content as follows:
1. Solid sawn lumber 2-inch thick or less: 19 percent.
  2. Plywood: 15 percent.
- F. Plywood Subflooring: Underlayment, Group 1, Exposure 1; of thickness indicated.
- G. Mineral Fiber Panels: Asbestos-free, thickness as indicated.
- H. Adhesive: Elastomeric adhesive – follow manufacturer's installation instructions. Product must be approved by OWNER Office of Environmental Health and Safety and conform to ASTM D 3498 or APA-AFG-01.

**PART 3 - EXECUTION****3.01 FASTENINGS****A. Nails and Spikes:**

1. Furnish only common wire nails or spikes whenever indicated, specified or required.
2. Whenever necessary to prevent splitting, holes shall be pre-drilled for nails and spikes.
3. Nails in plywood shall not be overdriven.
4. Machine Applied Nailing: Use of machine nailing is subject to a satisfactory Project site demonstration for each Project and approval by the Architect or structural engineer retained by the Architect as an Architect Consultant and DSA. Installation is subject to continued satisfactory performance. Machine nailing is not permitted for 5/16 inch plywood. Do not permit nail heads to penetrate outer ply. Maintain minimum allowable edge distances when installing nails.

**B. Lag Screws:**

1. When installing lag screws in a wood member, pre-drill hole as required by the CBC.
2. Lag screws, which bear on wood, shall be fitted with standard steel plate washers under head. Lag screws shall be screwed and not driven into place.

**C. Bolts:**

1. Lumber and timber to be fastened together with bolts shall be clamped together with holes for bolts bored true to line.
2. Bolts shall be fitted with steel plates or standard cut washers under heads and nuts. Bolts shall be tightened when installed and again before completion of the Work of this section.

**D. Wood Screws: When installing wood screws, pre-drill holes as required by the CBC.****E. Metal Framing Devices: Framing anchors, joist hangers, ties, and other mechanical fastenings shall be galvanized or furnished with a rust inhibitive coating. Nails and fastenings shall be of the type recommended by manufacturer.****F. Powder Driven Fasteners:**

1. Loads shall not exceed 75 pounds unless indicated on the Drawings or when reviewed by the Architect.
2. The operator, tool, and fastener shall perform the following as observed by the Inspector.
  - a. Observe installation of first 10 fasteners.
  - b. Test the first 10 fasteners by performing a pullout test. Load shall be at least twice the design load, or 150 pounds, whichever is greater.
  - c. Random testing:
    - 1) Load less than 75 pounds - approximately 1 in 10 pins.
    - 2) Load 75 pounds or greater - 1/2 of the pins.
3. Failure of any test will result in testing of all installed pins.
4. Nail heads shall not break the outer skin of sheathing.
5. Non-compliant pins shall be replaced.

### 3.02 INSTALLATION

#### A. Stud Walls, Partitions and Furring:

1. Wood stud walls, partitions and vertical furring shall be constructed of members of size and spacing indicated. Provide single treated plate at bottom and double plate at top unless otherwise indicated. Interior, nonbearing non-shear partitions may be framed with a single top plate, installed to provide overlapping at corners and at intersections with other wall and partitions or by metal ties as detailed.
2. Walls and partitions shall be provided with horizontal staggered blocking at least 2 inch nominal thickness and same width as studs, fitted snugly, and nailed into studs. Blocking shall be installed at mid-height of partition or not more than 7 feet on center vertically. Install wood backing on top of top plate wherever necessary for nailing of lath or gypsum board.
3. Walls, partitions and furred spaces shall be provided with 2-inch nominal thickness wood firestops, same width as space to be firestopped, at ceiling line, mid-height of partition and at floor line. Firestops at floor line are not required when floor is concrete. If width of opening is such that more than one piece of lumber is necessary, provide two thicknesses of one inch nominal material installed with staggered joints.

4. Firestops shall be installed in stud walls and partitions, including furred spaces, so the maximum dimension of any concealed space is not over 10 feet.
5. Corners, and where wood stud walls and wood vertical furring meet, shall be constructed of triple studs. Openings in stud walls and partitions shall be provided with headers as indicated and a minimum of 2 studs at jambs, one stud of which may be cut to support header in bearing.
6. Where wood and masonry or concrete walls intersect, end stud shall be fastened at top, bottom and mid-height with one 1/2 inch diameter bolt through stud and embedded in masonry or concrete a minimum of 4 inches. Bolts shall be provided with washers under nuts.
7. Sills under bearing, exterior or shear walls shall be bolted to concrete with 5/8 inch diameter by 12-inch long bolts with nuts and washers, spaced not more than 4 feet on center unless noted otherwise. There shall be a bolt within 9 inches of each end of each piece of sill plate. Sills shall be installed and leveled with shims, washers, with nuts tightened to level bearing. Space between sill and concrete shall be dry packed with cement grout.

**B. Floor Joists, Roof and Ceiling Framing:**

1. ~~Wood joists shall be of the size and spacing indicated, installed with crown edge up, and shall have at least 4 inch bearing at supports. Provide 2-inch solid blocking, cut in between joists, same depth as joists, at ends and bearings, unless otherwise indicated.~~
2. ~~Floor joists of more than 4 inches in depth and roof joists of more than 8 inches in depth shall be provided with bridging. Floor joists shall be bridged every 8 feet with solid blocking or metal cross bridging. Roof joists shall be bridged every 10 feet.~~
3. ~~Joists under and parallel to bearing partitions shall be doubled and nailed or bolted together as detailed. Whenever a partition containing piping runs parallel to floor joists, joists underneath shall be doubled and spaced to permit passage of pipes and blocked with solid blocking spaced at not more than 4 feet intervals.~~
4. ~~Trimmer and header joists shall be doubled, when span of header exceeds 4 feet. Ends of header joists more than 6 feet long shall be supported by framing anchors or joist hangers unless bearing on a beam, partition, or wall. Tail joists over 12 feet long shall be supported at header by framing anchors or on ledger strips at least 2 by 4.~~
5. ~~Provide solid blocking between rafters and ceiling joists over partitions and at end supports where indicated.~~

C. ~~Beams, Girders and Joists:~~

1. ~~Ends of wood beams, girders and joists which are 2 feet or less above finished outside grade and which abut, but do not enter concrete or masonry walls, as well as wood blocking used in connection with ends of those members shall be treated with wood preservative.~~
2. ~~Where wood beams, girders and joists enter masonry or concrete walls 2 feet or less above outside wall, metal wall boxes or equivalent moisture barriers shall be provided between wood and masonry or concrete.~~

D. ~~Subflooring:~~

1. ~~Floor sheathing: Plywood of thickness and nailing indicated. Install with the face grain direction across supports, end joints staggered and centered over supports. Provide solid blocking under plywood edges where indicated. In addition to nailing, sheets of plywood flooring shall be secured in place with elastomeric adhesive, installed at beams, joints, perimeter supports and panel edges.~~

E. ~~Roof and Wall Sheathing:~~

1. ~~Plywood roof sheathing shall be Structural I, Grade C-D, Exposure 1, thickness as indicated.~~
2. ~~Where exposed roof sheathing is indicated, area shall be sheathed solid with dressed and center matched, V-jointed boards of sizes indicated. Boards shall be installed perpendicular to supports.~~
3. ~~Soffits of overhanging eaves, where indicated, shall be boxed-in using Group I, Exterior Type, Grade A-C, plywood, thickness as indicated.~~
4. ~~Plywood for shear walls shall be Structural I, Grade C-D Exterior Type, thickness as indicated. Install with the long dimension parallel or perpendicular to the supports. Blocking shall be provided behind edges not located over supports. Shear wall construction, nailing, and top and bottom anchorage shall be as indicated.~~
5. ~~Provide and install metal H-clips of required size, midway between rafters at unsupported edge joints of plywood roof sheathing where rafters are spaced at 24 inches on center. Clips shall be Plyclips, by Timber Fasteners Inc., Panel Clips by Simpson Co., USP Structural Connectors, or equal.~~

F. ~~Attic Space Partitions and Attic Walkways:~~

1. ~~Attic space partitions shall be constructed of 2 by 4 wood members spaced at 2 feet on center maximum with 5/8 inch gypsum board.~~

2. ~~Doors in attic space partitions shall be self-closing, of the same sheathing material as partition, constructed with 2 battens and a diagonal brace across back.~~
3. ~~Shear walls passing through attic space shall be sheathed with 5/8 inch gypsum board on each side.~~
4. ~~Attic walkways shall be constructed of 2 by 12 planks installed one-inch apart and nailed at each support with three 16d nails.~~

G. Furring:

1. Rafters or ceiling joists indicated to be furred for support of materials other than acoustical tile shall be furred with 2 by 4 wood members installed at right angles to supports, spaced as indicated and nailed in place. Furring shall be aligned, and bottoms shall be leveled by installing wood shims as required, and nailed as indicated.
  2. Furring for protective wall padding in gymnasium shall be 1 by 3 Douglas fir, Construction Boards, S1S1E; applied horizontally to concrete walls at top and bottom of padding panels; and at uniform intermediate spacing not more than 18 inches on center. Stripping shall be shimmed where required, aligned to a true plane, and secured to concrete walls with concrete nails at not more than 18 inches on center.
- H. Furring: Where metal furring is not indicated or specified, provide wood furring at points indicated and required for concealing conduit, piping, structural framing or other unfinished materials. Wood furring shall be 2-by studs of required width. Vertical members contacting concrete or masonry shall be attached as specified for anchoring interior wood stud partitions.

I. Grounds:

1. Provide and set wood grounds at points where wood trim occurs and work is to be plastered. Grounds at 3/4 inch metal lath shall be 5/8 inch thick, net, 1 ½-inch wide Douglas Fir, S1S. Grounds shall be doubled where trim member exceeds 5-inch width, or wherever indicated. Grounds shall be applied after lath has been installed set plumb, level and true to line.
2. Apply grounds over wood framed surfaces and lath and securely nail to wood backing at each stud or bearing. Grounds applied over steel channel studs and lath shall be securely nailed at each stud or bearing to nail-blocks provided and installed in metal studs.
3. Grounds applied to concrete surfaces shall be securely nailed to woodblocks provided and built into concrete.

J. Nailing Strips and Plates:

1. Provide wood nailing strips, plates and blocking indicated or required. Nailing strips in connection with metal work shall be bolted to metal. Wood nailing blocks for securing grounds shall be built into concrete, or masonry.
  2. Nailing schedule shall comply with CBC requirements.
  3. Treated wood nailing strips for lightweight insulated concrete roof decks at eaves, ridges, rakes, base of curbs and wherever else indicated, shall be provided and installed. Strips shall be treated Douglas fir, 4 inches (nominal) width by thickness of insulated concrete.
- K. Wood Backing: Provide wood backing as indicated and as required to receive plumbing, electrical fixtures and equipment, cabinets, door stop plates and other fixed equipment.
- L. Wood Bucks: Furnish and set wood bucks to form openings for doors and other openings in concrete or masonry walls and in steel stud or channel partitions and furring. Bucks shall be Douglas fir, S1S2E, 2 inches (nominal) thickness and of width indicated or required. Bucks in connection with concrete shall be bolted thereto, and bucks in masonry walls shall be attached by means of strap anchors embedded in masonry joints. Bucks in connection with steel studs and metal channels shall be secured with nails or screws spaced not to exceed 24 inches on centers.
- M. Bench Tops and Backs: Tops and backs shall be 3/4 inch thick asbestos free board, fabricated to minimize number of joints. Edges shall be neatly cut, smoothly finished and joints accurately fitted and butted. Tops and backs shall be secured with countersunk flathead galvanized wood screws. At bench with steel pan, apply with manufacturer's recommended adhesive. Cut and drill as required for Work to be attached to benches.

#### 3.03 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

#### 3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

## SECTION 07 1400

## FLUID APPLIED WATERPROOFING

**PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Elastomeric waterproofing on planter and retaining walls not part of building walls.

**B. Related Requirements:**

1. Division 01 - General Requirements.
2. ~~Section 33 4000 - Storm Drainage Utilities.~~
3. Section 03 3000 - Cast-in-Place Concrete.
4. Section 04 2200 - Concrete Unit Masonry.

**1.02 SUBMITTALS**

- A. Certificates: Submit a certificate stating applicator is certified by the elastomeric waterproofing material manufacturer, and upon completion, submit a certificate stating that elastomeric waterproofing systems have been installed in conformance with reviewed submittals and manufacturer's recommendations.
- B. Product Data: Submit manufacturer's Product Data including complete installation instructions.
- C. Shop Drawings: Submit Shop Drawings indicating each condition of the Work. Indicate all adjoining Work, and indicate methods of adhesion, attachment, and related conditions.
- D. Samples: Submit Samples of elastomeric membrane waterproofing on flat plywood board, not less than 12 inches square, illustrating color and texture.
- E. Experience Record: Submit a list of at least five installations on which each of the materials and systems proposed for installation have been in satisfactory service for at least three years.

**1.03 QUALITY ASSURANCE****A. References:**

1. ASTM D6506, Standard Specification for Asphalt Based Protection for Below-Grade Waterproofing.
- B. Qualifications of Manufacturer: Elastomeric waterproofing system shall be manufactured by a firm with a minimum of 20 years experience in the production of elastomeric waterproofing.
- C. Qualifications of Installer: A firm which has at least three years experience in work of the type required by this section, and is recommended by manufacturer to install the specified products.
- D. Pre-Installation Conference and Inspection: After review of submittals but before starting installation of the Work of this section, conduct a meeting at the Project site attended by the Project Inspector, Architect, OAR, Contractor, waterproofing applicator, and a technical representative of the elastomeric waterproofing material manufacturer. The waterproofing applicator and material manufacturer's technical representative shall inspect the substrates to receive Work of this section and report defective conditions to Project Inspector, Architect, OAR and Contractor.
- E. Manufacturer's Representative: Provide arrangements necessary to have a trained representative of the manufacturer visit the Project site on a weekly basis during elastomeric waterproofing Work to review installation procedures.
- F. Materials shall comply with current State of California and local Air Quality Management District requirements for volatile organic compounds of not over 350 grams per liter.

#### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class and grade. Each container shall be identified with material name, date of manufacturer and batch number.
- B. Store materials at the Project site under cover and maintain in dry condition. Protect from damage from excessive temperature and construction operations. Do not double-stack containers. Protect mastic and adhesive from moisture and excessive heat.
- C. Store drainage composite or protection board flat and above grade. Provide cover on top and all sides of pallets and provide for adequate ventilation. Protect surface conditioner from freezing.

#### 1.05 PROJECT CONDITIONS

- A. Install suitable impervious type masking to preclude staining of surfaces to remain exposed wherever elastomeric waterproofing abuts or laps on to other finish surfaces, and provide additional protection as necessary to supplement masking; cover entire area of building subject to damage or staining.
- B. Protect adjacent Work during installation of Work of this Section.

- C. Install Work of this section, only in dry weather and when outside temperature is within the limits established by the manufacturer of the materials and products used.
- D. Do not install any materials when water in any form is present on the surface or if materials are wet.

#### 1.06 WARRANTY

- A. Manufacturer shall provide a three year material warranty.
- B. Installer shall provide a three year labor warranty.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Elastomeric waterproofing shall be a two-component, unmodified polyurethane waterproofing: Comply with ASTM C836.
  - 1. Pacific Polymers, Inc. Elasto-Deck B.T. 100 percent solids.
  - 2. Gaco Western, Inc. LM-60.
  - 3. Carlisle Coatings & Waterproofing Inc., CCW 703 Liquiseal.
  - 4. Tremco Inc., Temproof 201.
  - 5. Equal.

#### 2.02 MATERIALS

- A. Pacific Polymers, Inc., Elasto-Deck B.T. 100 percent solids System, as a standard of quality, conforming to the following:
  - 1. Application:
    - a. 60 mils thick – smooth surfaces.
    - b. 90 mils thick – rough surfaces.
  - 2. Material Types:
    - a. Type I: For horizontal surfaces.
    - b. Type II: For vertical surfaces.
    - c. Elasto-Deck B.T. Knifegrade: For cracks, voids and other surface irregularities.

## 2.03 RELATED MATERIALS

- A. Sealants: Compatible with waterproofing materials as recommended by manufacturer.
- B. Backer Rod: Closed-cell Polyethylene rod.
- C. Flashing Tape: Woven glass cloth tape.
- D. Protection Course: Minimum 1/8 inch thick complying with ASTM D6506, semirigid sheets of fiberglass or mineral-reinforced asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.
- E. Cleaning Materials: Solvent recommended by manufacturer.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Surfaces must be clean and free of any oil, dirt, grease, and other contaminants, which will interfere with adhesion of the coatings. Surfaces shall be left broom clean.
- B. Concrete:
  - 1. Concrete surfaces shall be trowel finished followed by a light brooming, left free of loose particles, ridges, projections, voids and droppings that would interfere with the application of the coatings.
  - 2. Concrete surfaces shall be water cured in lieu of curing compounds for a minimum of 28 days. If curing compounds are furnished, they shall be compatible with the provided waterproofing system.
- C. Substrate conditions and surfaces shall be subject to inspection by the manufacturer and installer. Do not proceed with Work until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Protect building from damage resulting from spillage, dripping and dropping of materials. Prevent materials from entering and clogging drains and waterways.
- B. Concrete
  - 1. Surfaces to receive elastomeric waterproofing system shall be cleaned by sandblasting or acid etching. If acid etching is provided, a 10 percent to 15 percent muriatic acid solution applied by mop or broom, shall be allowed to remain on the surface approximately 10 minutes or until bubbling ceases. Surfaces shall then be washed with clean water to remove residues and shall be allowed to dry.

### C. Cracks and Control Joints

1. Except for non-moving shrinkage cracks, all other cracks and joints must be sealed with a single component sealant of the same manufacturer as the elastomeric membrane waterproofing and installed according to manufacturer's recommendations.
2. Large cracks, 1/16 inch and over, shall be routed out as required by the manufacturer and sealed with an elastomeric sealant. Apply sealant to inside area of cracks only. Do not install on concrete deck surfaces.
3. Seal secondary control and expansion joints with sealant and backer rod as recommended in the installation specifications of the elastomeric membrane waterproofing.

### 3.03 INSTALLATION

- A. Install Elastomeric membrane waterproofing in accordance with manufacturer's printed instructions except as hereinafter specified. Coordinate the Work so the complete membrane is installed in a continuous operation, and that all areas where installation has started, per coat, are completed the same working day.
- B. Elastomeric Membrane Waterproofing - 60 mils thickness, Smooth Surface Installation:
  1. Cracks 1/16 inch and over shall be routed or saw cut and filled with joint filler of the same manufacturer as the elastomeric membrane waterproofing and installed according to manufacturer's recommendations.
  2. At intersections of membrane and vertical walls, columns, pipes, and other penetrations, install a 3/4 inch fillet bead at the meeting angle using a joint filler of the same manufacturer as the elastomeric membrane waterproofing and installed according to manufacturer's recommendations.
  3. Install the first coat of the elastomeric membrane waterproofing at a rate of 50 square feet per gallon by airless spray, roller, brush, or squeegee according to the manufacturers installation procedures for smooth surfaces.
  4. After a 24 hour curing period, install a second coat of elastomeric membrane waterproofing at the same 50 square feet per gallon rate to provide a total dry film thickness of 60 mils.
- C. Elastomeric Membrane Waterproofing -- 90 mils thickness, Rough Surface Installation:
  1. Cracks 1/16 inch and over shall be routed or sawcut and filled with joint filler of the same manufacturer as the elastomeric membrane waterproofing and installed according to manufacturer's recommendations.

2. At intersections of membrane and vertical walls, columns, pipes and other penetrations, install a  $\frac{3}{4}$  inch fillet bead at the meeting angle using a joint filler of the same manufacturer as the elastomeric membrane waterproofing and installed according to manufacturer's recommendations.
3. Install the first coat of elastomeric membrane waterproofing at a rate of 35 square feet per gallon by airless spray, roller, brush, or squeegee according to the manufacturers installation procedures for rough surfaces.
4. After a 24 hour curing period, install a second coat of elastomeric membrane waterproofing at the same 35 square feet per gallon rate to provide a total dry film thickness of 90 mils.

#### 3.04 INSPECTION

- A. The wet film thickness of each coat shall be checked during application by averaging numerous measurements taken with a film gage and thickness shall be sufficient that when cured the dry film thickness will be as specified herein.
- B. Surfaces coated shall be visibly checked to insure areas have not been missed and all holidays in the film are repaired.
- C. Coating Work shall be subject to inspection at any time to insure compliance with the manufacturer's recommendations. Test areas shall be cut whenever requested by the manufacturer's technical representative to verify conformance to the Specifications. Unsatisfactory area shall be remedied by the applicator.

#### 3.05 PROTECTION COURSE

- A. Install protection board on cured membrane after testing, without delay, so that the period of exposure shall be minimized.

#### 3.06 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

#### 3.07 CLEAN UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

## SECTION 07 9200

## JOINT SEALANTS

## PART 1 - GENERAL

## 1.01 SUMMARY

- A. Section Includes:
  - 1. Joint sealants.
  - 2. Preparation for application of sealants.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. ~~Section 07 6000 - Flashing and Sheet Metal.~~
  - 3. ~~Section 07 8413 - Penetration Firestopping.~~
  - 4. Division 09 - Finishes.
  - 5. ~~Section 10 2813 - Toilet Accessories.~~

## 1.02 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating sealant joint locations, with full-size sealant joint details.
- B. Product Data: Submit manufacturer's literature for each sealant material.
- C. Material Samples: Submit Samples indicating color range available for each sealant material intended for installation in exposed locations.
- D. Certifications: Submit manufacturer's certification materials comply with requirements specified.
- E. Site Samples: At locations required, provide a Sample of sealant for each typical installation, approximately 24 inches long, including joint preparation, backing, sealant and tooling. Allow backing to extend 6 inches beyond end of sealant for inspection of substrate.
- F. Test Reports: Submit manufacturer's adhesion compatibility test reports according to ASTM C794 for each substrate.

## 1.03 QUALITY ASSURANCE

- A. Qualifications of Installer: The Work of this section shall be installed by a firm which has been in the business of installing similar materials for at least five consecutive years; and can show evidence of satisfactory completion of five projects of similar size and scope. Installer shall have applicators trained and approved by manufacturer for performing this Work.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Store in accordance with manufacturer's recommendations. Provide a uniform ambient temperature between 60 and 80 degrees F.

1.05 WARRANTY

- A. Manufacturer: five year material warranty.  
B. Installer: two year installation/application warranty.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish sealants meeting following in-service requirements:
1. Normal curing schedules are permitted.
  2. Non-staining, color fastness (resistance to color change), and durability when subjected to intense actinic (ultraviolet) radiation are required.
- B. Furnish the products of only one manufacturer unless otherwise required, sealant colors as selected to match the adjoining surfaces.

2.02 MANUFACTURERS

- A. Sealants must be approved by LAUSD's Office of Environmental Health and Safety (OEHS). Check OEHS website for approved products. Not all products by a manufacturer are approved by OEHS.

2.03 MATERIALS

- A. Sealants:
1. Sealant 1: Acrylic latex, one-part, non-sag, mildew resistant acrylic emulsion compound complying with ASTM C834, Type S, Grade NS, formulated to be paintable.
    - a. Tremco Inc., Acrylic Latex Caulk.
    - b. Pecora Corporation, AC-20.
    - c. Equal.

2. Sealant 2: Butyl sealant, one-part, non-sag, solvent-release-curing sealant complying with ASTM C1311, gun grade and formulated with a minimum of 75 percent solids.
  - a. Tremco Inc., Tremco Butyl Sealant.
  - b. Pecora Corp., BC-158.
  - c. Equal.
3. Sealant 3: Silicone sealant, one-part non-acid-curing silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25.
  - a. Dow Corning Corp., Dow Corning 790, 791, 795.
  - b. General Electric Co., Silpruf.
  - c. Tremco, Inc., Spectrem 1.
  - d. Pecora Corp., 864.
  - e. Equal.
4. Sealant 4: One-part mildew-resistant silicone sealant, complying with ASTM C920, Type S, Grade NS, Class 25.
  - a. Dow Corning Corp., Dow Corning 786.
  - b. General Electric Co., Sanitary 1700.
  - c. Tremco, Inc., Proglaze White.
  - d. Equal.
5. Sealant 5: One-part non-sag urethane sealant, complying with ASTM C920, Type S, Grade NS, Class 25.
  - a. Sika Corporation, Sikaflex -221e.
  - b. Equal.
6. Sealant 6: Multi-part pouring urethane sealant, complying with ASTM C920, Type M, Grade P, Class 25.
  - a. Sika Corporation, Sikaflex 2C NS/SL.
  - b. Equal.
7. Sealant 7: Acoustical sealant, non-drying, non-hardening permanently flexible conforming to ASTM D217.
  - a. Pecora Corp., BA-98 Acoustical Sealant.

- b. Equal.
- B. See 07 8413 - Penetration Firestopping for rated sealants.
- C. Joint Backing: ASTM D1056; round, closed cell Polyethylene Foam Rod; oversized 30 to 50 percent larger than joint width, reticulated polyolefin foam.
- D. Primer: Non-Staining Type. Provide primer as required and shall be product of manufacturer of installed sealant.
- E. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer.
- F. Sealants shall have normal curing schedules, shall be nonstaining, color fast and shall resist deterioration due to ultraviolet radiation.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify that joint openings are ready to receive Work and field tolerances are within the guidelines recommended by sealant manufacturer.

#### 3.02 SURFACE PREPARATION

- A. Joints and spaces to be sealed shall be completely cleaned of all dirt, dust, mortar, oil, and other foreign materials which might adversely affect sealing Work. Where necessary, degrease with a solvent or commercial degreasing agent. Surfaces shall be thoroughly dry before application of sealants.
- B. If recommended by manufacturer, remove paint and other protective coatings from surfaces to be sealed before priming and installation of sealants.
- C. Preparation of surfaces to receive sealant shall conform to the sealant manufacturer's specifications. Provide air pressure or other methods to achieve required results. Provide masking tape to keep sealants off surfaces that will be exposed in finished Work.
- D. Etch concrete or masonry surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5 percent solution of muriatic acid; neutralize with dilute ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.
- E. Perform preparation in accordance with ASTM C804 for solvent release sealants, and ASTM C962 for elastomeric sealants.
- F. Protect elements surrounding Work of this section from damage or disfiguration.

#### 3.03 SEALANT APPLICATION SCHEDULE

	Location	Type	Color
A.	Exterior and Interior joints in	Sealant 6	To match adjacent

	horizontal surfaces of concrete; between metal and concrete masonry and mortar.		material
B.	Exterior door, entrance and window frames. Exterior and interior vertical joints in concrete and masonry metal flashing.	Sealant 3 or 5	To match adjacent material
C.	Joints within glazed curtain wall system. Skylight framing system. Aluminum entrance system glass and glazing.	Sealant 3	Translucent or Black
D.	Interior joints in ceramic tile and at plumbing fixtures.	Sealant 4	Translucent or White
E.	Under thresholds.	Sealant 2	Black
F.	All interior joints not otherwise scheduled	Sealant 1	To Match Adjacent Surfaces
G.	Heads and sills, perimeters of frames and other openings in insulated partitions	Sealant 7	Match Adjacent Surfaces
3.04	APPLICATION		
A.	Provide sealant around all openings in exterior walls, and any other locations indicated or required for structure weatherproofing and/or waterproofing.		
B.	Sealants shall be installed by experienced mechanics using specified materials and proper tools. Preparatory Work (cleaning, etc.) and installation of sealant shall be as specified and in accordance with manufacturer's printed instructions and recommendations.		
C.	Concrete, masonry, and other porous surfaces, and any other surfaces if recommended by manufacturer, shall be primed before installing sealants. Primer shall be installed with a brush that will reach all parts of joints to be filled with sealant.		
D.	Sealants shall be stored and installed at temperatures as recommended by manufacturer. Sealants shall not be installed when they become too jelled to be discharged in a continuous flow from gun. Modification of sealants by addition of liquids, solvents, or powders is not permitted.		

- E. Sealants shall be installed with guns furnished with proper size nozzles. Sufficient pressure shall be furnished to fill all voids and joints solid. In sealing around openings, include entire perimeter of each opening, unless indicated or specified otherwise. Where gun installation is impracticable, suitable hand tools shall be provided.
- F. Sealed joints shall be neatly pointed on flush surfaces with beading tool, and internal corners with a special tool. Excess material shall be cleanly removed. Sealant, where exposed, shall be free of wrinkles and uniformly smooth. Sealing shall be complete before final coats of paint are installed.
- G. Comply with sealant manufacturer's printed instructions except where more stringent requirements are indicated on Drawings or specified.
- H. Partially fill joints with joint backing material, furnishing only compatible materials, until joint depth does not exceed 1/2 inch joint width. Minimum joint width for metal to metal joints shall be 1/4 inch. Joint depth, shall be not less than 1/4 inch and not greater than 1/2 inch.
- I. Install sealant under sufficient pressure to completely fill voids. Finish exposed joints smooth, flush with surfaces or recessed as indicated. Install non-tracking sealant to concrete expansion joints subject to foot or vehicular traffic.
- J. Where joint depth prevents installation of standard bond breaker backing rod, furnish non-adhering tape covering to prevent bonding of sealant to back of joint. Under no circumstances shall sealant depth exceed 1/2 inch maximum, unless specifically indicated on Drawings.
- K. Prime porous surfaces after cleaning. Pack joints deeper than 3/4 inch with joint backing to within 3/4 inch of surface. Completely fill joints and spaces with gun applied compound, forming a neat, smooth bead.

#### 3.05 MISCELLANEOUS WORK

- A. Sealing shall be provided wherever required to prevent light leakage as well as moisture leakage. Refer to Drawings for condition and related parts of Work.
- B. Install sealants to depths as indicated or, if not indicated, as recommended by sealant manufacturer but within following general limitations:
  1. For joints in concrete walks, slab and paving subject to traffic, fill joints to a depth equal to 75 percent of joint width, but not more than 3/4 inch deep or less than 3/8 inch deep, depending on joint width.
  2. For building joints, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep or less than 1/4 inch deep.

#### 3.06 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

#### 3.07 CURING

111001

- A. Sealants shall cure in accordance with manufacturer's printed recommendations. Do not disturb seal until completely cured.

3.08 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 09 2423  
CEMENT PLASTER AND METAL LATH

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Lath and Portland cement plaster and stucco.
2. Lath and scratch coat of Portland cement plaster as a substrate for ceramic wall tile.

**B. Related Requirements:**

1. Division 01 - General Requirements.
2. Section 03 3000 – Cast-in-Place Concrete.
3. Section 04 2200 – Concrete Unit Masonry.
4. ~~Section 05 4100 Structural Metal Stud Framing.~~
5. Section 06 1000 - Rough Carpentry.
6. ~~Section 07 2100 Thermal Insulation.~~
7. ~~Section 07 2719 Plastic Sheet Air Barriers.~~
8. ~~Section 09 2216 Non-Structural Metal Framing.~~
9. Section 09 3013 - Ceramic Tiling.

**1.02 SYSTEM DESCRIPTION**

- A. Two coat 1/2" to 5/8" cement plaster on metal lath over CMU.
- B. Two coat 1/2" to 5/8" cement plaster over CMU.
- C. Two coat 1/2" to 5/8" cement plaster over concrete.
- D. Two coat 1/2" to 5/8" cement plaster over concrete.
- E. Soffits and ceilings: Three coat 7/8" cement plaster on metal lath over suspended metal framing.
- F. One coat cement plaster base for ceramic tile installation.

## 1.03 REFERENCES

## A. ASTM International (ASTM):

1. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A510 - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel.
3. ASTM A641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
4. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
5. ASTM C150 – Standard Specification for Portland Cement.
6. ASTM C206 – Standard Specification for Finishing Hydrated Lime.
7. ASTM C841 - Standard Specification for Installation of Interior Lathing and Furring.
8. ASTM C847 - Standard Specification for Metal Lath.
9. ASTM C897 – Standard Specification for Aggregate for Job Mixed Portland Cement-Based Plasters.
10. ASTM C926 – Standard Specification for Application of Portland Cement-Based Plaster.
11. ASTM C932 - Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering.
12. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
13. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
14. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
15. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.
16. ASTM E1190 – Standard Test Methods for Power-Actuated Fasteners Installed in Structural members.

## B. Federal Specifications (FS):

1. FS FF-N-105: Nails, Brads, Staples and Spikes: Wire, Cut and Wrought.
2. UU-B-790A: Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent, and Fire Resistant).

C. International Code Council (ICC):

1. ICC-ES AC11: Acceptance Criteria for Cementitious Exterior Wall Coatings.
2. ICC-ES AC 191: Acceptance Criteria for Metal Plaster Bases (Lath).

**1.04 SUBMITTALS**

- A. Product Data: Submit manufacturer's product data for each material and component proposed for installation.
- B. Plaster Samples: Submit minimum 48-inch by 48-inch samples of each stucco and Portland cement plaster texture for review. Samples shall be representative of texture, color, and proposed fabrication and finish quality. Maintain reviewed Samples on Project site for reference.
- C. Accessories Samples: Submit 12 inch long samples of metal lath accessories: control joints, expansion joints, corner reinforcements, reveals and screeds.
- D. Certificates: Submit test reports or ICC Evaluation Reports indicating that materials are in compliance with CBC requirements. Cementitious materials shall meet the acceptance requirements of ICC AC11, and metal lath the acceptance requirements of ICC AC191.

**1.05 QUALITY ASSURANCE**

- A. Mock-ups:
  1. Constructed separately from the building but on Project site.
  2. Constructed as part of the building.
  3. Provide a mock-up at least 10-foot wide by 10-foot high. Include at least one control joint and, corner condition and one window opening flashing. Locate where indicated by the ARCHITECT.
  4. Mock-up shall be constructed by the same personnel who will be erecting the different components of the wall assembly on the project, overseen by the same personnel who will be acting as supervisors during actual construction, and built with the same construction techniques and materials that will be used on the project.
  5. Wall/window assembly will be tested by a lab retained by the OWNER for air and water infiltration in accordance to ASTM E1105 and ASTM E783.
- B. Pre-Installation Conference: CONTRACTOR shall coordinate and conduct pre-installation conference in accordance to Section 01 3119, Project Meetings, to review

the progress of construction activities and preparations for the installation of metal lath and cement plaster and other related work of this Section.

## 1.06 DELIVERY, STORAGE AND HANDLING

- A. Store weather sensitive materials under cover, off the ground, and kept in a dry condition until ready for use.
- B. Deliver materials to the Project site in manufacturer's sealed and labeled packages.

## PART 2 - PRODUCTS

### 2.01 METAL LATH AND WEATHER RESISTIVE BACKING

- A. Metal Lath:
  - 1. Walls and Ceilings: Diamond mesh expanded metal lath, in conformance to ASTM C847, without paper backing. 3.4 pounds per square yard, hot-dip galvanized coating G60 in accordance with ASTM A653. Alabama Metal Industries Corporation (AMICO), California Expanded Metal Products Company (CEMCO), ClarkDietrich, Marino-Ware, or equal.
    - a. V-grooved self-furring type for installation over sheathing. Lath shall be furred out a minimum of 1/4 inch when installed over a solid surface in accordance to DSAIR 25-4.
    - b. Flat type for installation over spaced framing.
  - 2. Walls: Self-furring Welded Wire Lath: Weight 1.95 pounds per square yard, with Class 1 galvanized coating in conformance to ASTM A641. Structa Mega Lath per ICC ESR-2017, as manufactured by Structa Wire Corp, or equal.
  - 3. Walls & Ceilings: Self-furring Welded Wire Lath: Weight 2.2 pounds per square yard, with Class 1 galvanized coating in conformance to ASTM A641 with heavy perforated Kraft paper. V-Truss per ICC ESR-2017, as manufactured by Structa Wire Corp, or equal.
- B. Water Resistive Barrier Backing for Metal Lath:
  - 1. One layer of air barrier membrane per Section 07 2719, Plastic Sheet Air Barriers.
  - 2. One layer of asphalt saturated, water resistant Kraft paper backing conforming to Fed Spec UU-B-790A, Type 1, Grade D60, manufactured by Fortifiber, Davis Wire, Leather back, or equal. Furnish for exterior plastering (except on soffits and ceilings), and for mortar-set ceramic wall tile.
- C. Self-Adhered Flashing:

1. Compatible with the Plastic Sheet Air Barrier, minimum 25 mils thick, self-sealing and waterproof.
2. Adhesives, primers and sealers for self-adhered flashings and water repellent backing shall be as recommended by manufacturer for installation with specified products and substrates, and shall be approved by the OWNER's Office of Environmental Health and Safety (OEHS).

## 2.02 METAL LATH ACCESSORIES

- A. Materials: Minimum 0.0172 inch galvanized steel or 0.0207 zinc alloy with expanded wings. PVC is not permitted. Furnish casing beads, expansion and control joints, weep and vent screeds.
- B. Manufacturers: Alabama Metal Industries Corporation (AMICO), California Expanded Metal Products Company (CEMCO), ClarkDietrich, Stockton Products, Marino-Ware, equal.
- C. Products:
  1. Exterior Stress Relief Joints: Sizes and profiles, indicated or required. Control joints shall have expanded wings when attachment flange is installed above the primary water-resistant barrier.
  2. Expansion Joints: Two piece sections designed to accommodate expansion, contraction and shear forces. Industry generic name: #40-2 piece joint.
  3. Control Joints: One-piece sections, with flange designed to engage plaster. Grounds shall provide full 7/8 inch thickness of cement plaster. Industry generic name: XJ-15.
  4. Soffit Drip Screed: Similar to Stockton Products No. 5, with key holes.
  5. Casing Beads: Expanded or standard flange type with 7/8 inch grounds to establish plaster thickness. Industry generic names: J-Mold or # 66.
  6. Welded Wire Corner Reinforcement: 2-5/8 inch wire wings square or bullnose. Industry generic name: CornerAid.
  7. Inner Corner Reinforcement: Shaped reinforcing expanded metal with 3 inch legs, for angle reinforcement. Industry generic name: Cornerite.
  8. Lath Reinforcement: Flat expanded metal lath reinforcing units. Industry generic name: Striplath.
  9. Outside Corner Reinforcing: 2 1/2" legs Class 1 Galvanized Coating complying with ASTM A641. VTruss Straight Corner per ICC ESR-2017, as manufactured by Structa Wire Corp, or equal.
  10. Ventilating Screeds: Soffit, attic, fascia, edge, channel and expansion channel vent screeds, perforated web type, with integral plaster grounds, of sizes indicated on drawings.

11. Foundation Weep Screeds: Integral plaster ground and weep screed; 3-1/2" minimum attachment flange. Industry generic name: #7 Weep Screed.
12. Foundation Casing at Walls with Continuous Insulation: Custom shaped galvanized steel "J" mold with weep holes. Width shall be sized to accommodate insulation thickness plus 7/8 inch plaster.

## 2.03 LATH FASTENERS

- A. Fasteners through Continuous Insulation: Fastener spacing as indicated on drawings.
  1. Wood Studs: Fasteners shall be corrosion resistant.
    - a. Nails: In accordance to FS FF-N-105, [0.113 inch] [0.120 inch] [0.131 inch] with a 3/8 inch diameter head with length that penetrates wood framing (exclusive of sheathing) 1-1/4 inch minimum.
    - b. Lag Screws: 1/4 inch diameter with length that penetrates wood framing (exclusive of sheathing) 1-1/2 inch minimum.
  2. Metal Studs: Corrosion resistant coated wafer head steel [#8] [#10] screws with length that penetrates framing steel thickness plus three threads minimum.
- B. Fasteners at Locations with no Continuous Insulation:
  1. Wood Studs: Fasteners shall be corrosion resistant.
    - a. Nails: In accordance to FS FF-N-105, 0.113 with a 3/8 inch diameter head with length that penetrates wood framing (exclusive of sheathing) 3/4 inch minimum.
    - b. Screws: Type A, in accordance to ASTM C1002, length that penetrates wood framing (exclusive of sheathing) 3/4 inch minimum.
    - c. Staples: In accordance to FS FF-N-105. Minimum 3/4 inch crown, 0.053 inch steel. Staples shall have sufficient length to penetrate studs at least 3/4 inch.
  2. Metal Studs: Wafer head type S or S-12, corrosion resistant, with length to penetrate framing steel thickness plus three threads minimum.
    - a. Screws for fastening to steel members from 0.033 inch to 0.112 inch in thickness shall be in accordance to ASTM C954.
    - b. Screws for fastening to steel members 0.033 inch in thickness and less shall be in accordance to ASTM C1002.
- C. Fasteners for Concrete and CMU Substrates: Power Actuated Fasteners: For attachment of lath to concrete and concrete masonry, recommended by manufacturer for the specific use intended. Minimum 3/4 inch long hardened drive style pin with a 1/2 inch diameter style washer. Fasteners shall be corrosion resistant and provide minimum withdrawal resistance of 50 pounds minimum.

- D. Wire: Wire for fastening lath to supports, tying ends and edges of lath sheets, and securing accessories to lath, 0.0475 inch diameter (# 18 wire). Galvanized soft-annealed steel wire in conformance to ASTM A641.

## 2.04

~~MATERIALS FOR SUSPENDED CEILINGS~~

- A. Main Runners and Cross Furring Channels: Cold-formed channels made from steel with minimum 33,000 psi yield strength 0.0538 inch minimum bare steel thickness. Channel shall have a protective G60 galvanized coating conforming to ASTM A653.
- ~~1. Main Runners: [in depth indicated] [1-1/2 inches deep] [2 inches deep] [2 1/2 inches deep].~~
  - ~~2. Cross Furring: 3/4 inch deep.~~
- B. Wire: Galvanized soft-annealed mild steel wire in conformance to ASTM A641, Class 1 coating. Ultimate stress value of 60,000 psi and design value not to exceed 24,000 psi per DSA IR 25-1.
- ~~1. Hanger wire for suspended ceilings, minimum 0.1620 (8 gauge), 0.135 inch diameter (10 gauge), and 0.106 (12 gauge).~~
  - ~~2. Wire for saddle-tying cross furring to main runners, 0.0625 inch diameter (16 gauge) for single strand tying and 0.0475 (18 gauge) for double strand tying.~~
- C. Hangers:
- ~~1. Rod Hangers: ASTM A510, mild carbon steel, hot-dip galvanized per ASTM A153.~~
  - ~~2. Flat Hangers: Commercial-steel sheet, 1 by 3/16 inch with G60, hot-dip galvanized zinc coating per ASTM A653.~~
- ~~3. Ceiling Clips: Commercial steel sheet, 3/4 inch wide minimum by 12 gauge minimum, with G60, hot-dip galvanized zinc coating per ASTM A653.~~
- D. ~~Hanger Attachments to Concrete: Power-actuated fasteners that use explosive powder, gas combustion, or compressed air or other gas to embed fasteners in concrete and that are suitable for application indicated. Fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers. Capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E1190 by a qualified independent testing agency.~~

## 2.05

## PLASTER MATERIALS

- A. Factory Blended Portland Cement Plaster Basecoats and Finish: Products as fabricated by California Stucco, La Habra, Shamrock Stucco, Merlex, Omega Stucco, Inc., Expo Stucco, Spec Mix, Quikrete or other manufacturer member of the Stucco Manufacturer's Association (SMA).
1. Material Standards:

- a. Portland Cement: ASTM C150.
  - b. Hydrated Lime: ASTM C206.
  - c. Sand: ASTM C897.
  - d. Fibers: ASTM C1116.
2. Three Coat Systems:
    - a. Scratch and Brown Coats: Factory blended fiber reinforced plaster and sand mix conforming to ASTM C926, and requiring only the addition of water. Total thickness of coats: 3/4 inch.
    - b. Finish Coat: Factory blended cementitious stucco color coat, integrally colored with fade-resistant pigments. Coat thickness 1/8 inch.
      - 1) Finish: **[Light Dash] [Light Sand]**
      - 2) Color: As selected by ARCHITECT.
  3. Two Coat Systems:
    - a. Brown Coat: Factory blended fiber reinforced plaster and sand mix conforming to ASTM C926, and requiring only the addition of water. Coat thickness 3/8 to 1/2 inch.
    - b. Finish Coat: Factory blended cementitious stucco color coat, integrally colored with fade-resistant pigments. Coat thickness 1/8 inch.
      - 1) Finish: **[Light Dash] [Light Sand]**
      - 2) Color: As selected by ARCHITECT.
- B. Water: Clean, potable and from domestic source.
- C. Plaster Bonding Agent: In conformance to ASTM C932 and formulated for exterior use. "Weld-Crete", manufactured by Larsen Products Co., or equal.
- D. Plaster Patching Materials:
1. Bonding Agent: Acrylic resin type, Acryl 60, LHP Bonder, or equal.
  2. Patching Plaster: Manufactured by Merlex Stucco, Inc., or equal. Furnish fast setting, compatible with existing plaster materials, "Exterior Pronto Patch," Portland cement base coat material, requiring only addition of water. Material shall provide initial set within 20 minutes and final set within one hour.
- E. Flashing: Single ply self-adhesive waterproofing membrane as manufactured by W.R. Grace Company, Jiffy-Seal by Protecto Wrap, W.R. Meadows, Inc., or equal. Furnish for installation behind stress relief joints and backing on horizontal and vertical surfaces exposed to weather; under metal copings and flashings; and window jambs and sills.

03/12/2015

- F. Continuous Insulation: Refer to Section 07 2100, Thermal Insulation.
- G. Miscellaneous Materials: Provide additional components and materials required for a complete installation.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify that installation of plastic sheet air barrier and flashings, per Section 07 2719, and continuous insulation per Section 07 2100 are complete before starting Work of this Section.

#### 3.02 INSTALLATION-OF WATER RESISTIVE BARRIER

- A. Install one layer of water resistant barrier over air barrier. Install Kraft paper horizontally with each course weather lapped 2 inches over layer below and 6 inches on ends.
- B. Repair and seal tears and holes in water resistive barrier prior to installing lath.
- C. Install single ply self-adhesive flashing per manufacturer's recommendations in areas indicated on the Drawings and at locations where the plaster will be in less than a 60 degree plane or where water can pond, with a six inches extension onto the vertical wall surface. Apply self-adhesive flashing in a "shingle fashion".

#### 3.03 ~~INSTALLATION OF SUSPENDED CEILING METAL FURRING~~

- A. ~~Install ceiling metal furring in conformance to drawings and ASTM C1063.~~
- B. ~~Space [hanger wires],[rod hangers], [flat hangers] as indicated on drawings along carrying channels and within 6 inches of ends of carrying channel run. Connect to underside of structure as indicated on drawings.~~
- C. ~~Install 1-1/2 inch carrying channels at spacing indicated on drawings and within 6 inches of walls, positioned for proper ceiling height. Level and secure with hanger wire saddle-tied along channel. Provide one inch clearance between runners and abutting walls. At channel splices interlock flanges, overlap ends 12 inches and secure each end with 16 gauge tie wire or double-strand 18 gauge tie wire.~~
- D. ~~When flat hangers are used, bend tightly hanger around main runners and carried up and above the runners and fasten through with 3/8 inch round-head stove bolts. Nuts of bolts shall be drawn up tight. Smooth or threaded rod hangers shall be fastened to the runners with special attachments appropriate to the design.~~
- E. ~~Erect 3/4 inch cold-rolled furring channels at right angles to 1-1/2 inch carrying channels, and secure to furring channels by wire-tying with double-strand 18 gauge wire. At splices nest furring channels eight inches and securely wire-tie each end with single strand 16 gauge wire or double-strand 18 gauge wire.~~

- F. ~~Fasten wires with four (4) tight turns. Make all tight turns within a distance of one and one-half (1-1/2) inches.~~

### 3.04 INSTALLATION OF LATH AND LATH ACCESSORIES

- A. Exterior Lathing, General: Install in conformance to ASTM C1063 and CBC Chapter 25.
- B. Install longest length of metal lath as possible. Do not use pieces shorter than six feet in length. Attach lath to framing supports not more than seven (7) inches apart along framing supports only.
- C. Apply metal lath with long dimension at right angles to framing or furring supports and lap lath a minimum 1/2 inch at sides and minimum 1 inch on ends. Lap wire lath minimum one mesh on sides and ends. Stagger vertical laps at least 16 inches. Lath shall lap flanges of solid flanged trim accessories by a minimum of 50%.
- D. Ends of lath on open framing (unsheathed) shall occur over supports. Where necessary, install additional studs to provide support for lath ends and support for separate flanges of stress relief joints.
- E. Install trim accessories plumb, level and straight, attachments should not exceed 24 inches on center.
- F. Lath shall not be continuous through control joints. Two-piece Expansion Joints shall have the lath cut, be attached to framing and lath lap the flanges. Place control joints as indicated on elevations. Water resistant barrier shall be continuous behind all control joints and vertical reveals.
- G. Install a weep screed at or below foundation plate line on exterior stud walls in conformance to CBC section 2512. Screed shall be of a type permitting water to drain to exterior of building. Weather-resistant barrier and exterior lath shall cover and terminate on attachment flange of screed.
- H. Powder Actuated Fasteners shall be used on concrete/masonry substrates when lath is applied. Fasteners shall be driven home and avoid spalling of concrete. Pattern shall simulate that of framed walls.
- I. Interior Lathing, General: Install in conformance to ASTM C841 and CBC Chapter 25.
- J. Metal lath shall be fastened to metal supports with specified fastener spaced not more than 6 inches apart or with other recognized fasteners.

### 3.05 PLASTER APPLICATION - GENERAL

- A. Verify that installation of lath is complete prior to start plastering. Notify the Technical Service Information Bureau upon completion of lath and prior to start of plaster to schedule a lathing installation compliance meeting. TSIB will submit a written field observation report delineating any deficiencies. Site meeting shall be coordinated with OAR.

03/12/2015

- B. Proportion, mix, apply, and cure plaster in conformance with ASTM C926 and CBC Chapter 25.
- C. Install each plaster coat to an entire wall or ceiling panel without interruption to avoid cold joints and abrupt changes in uniform appearance of succeeding coats. Wet plaster shall abut existing plaster at naturally occurring interruptions in plane of plaster (such as corner angles, openings and control joints) wherever possible. Cut joining, where necessary, square and straight and at least 6 inches away from a joining in preceding coat.
- D. Provide sufficient moisture or curing methods to permit continuous and complete hydration of cementitious materials, considering climatic and Project site conditions. If water cured, each basecoat shall be continuously damp for at least 48 hours, including weekends and holidays. Other curing methods, spray applied curing compounds, or OEHS approved equal are permitted.
- E. Provide sufficient time between coats to permit each coat to cure or develop enough rigidity to resist cracking or other damage when next coat is installed.

### 3.06 EXTERIOR PLASTERING

- A. Concrete surfaces, except where noted as "Exposed Concrete" or "Painted Concrete," shall be finished with stucco **light sand** finish coats, as specified.
- B. Preparation of Concrete and Masonry Surfaces:
  - 1. Exterior concrete and masonry surfaces to be plastered shall be free of oily or waxy substances, and loose or foreign material. Uniformly spray with nozzle-type water spray at least 12 hours before installation of plaster or as required to control suction.
  - 2. Concrete and masonry surfaces to receive two coat application of 5/8 inch thick Portland cement plaster shall be treated with bonding agent. This surface preparation shall not be installed instead of a brown coat of plaster.
  - 3. Concrete surfaces to receive stucco dash finish shall be lightly sandblasted to provide a roughened surface.
  - 4. Verify that lath has been installed securely and that grounds, screeds, casing beads and other accessories are straight, in correct position, and securely fastened in place.
- C. Mixing: Provide plaster mix: cementitious materials and aggregate in proportions specified, furnishing only sufficient water to obtain proper consistency before installation. Do not mix any more material at any time than can be installed within 1/2 hour after mixing. Do not re-temper. Add only enough water to allow proper application of cement plaster.
- D. Application:

1. **[Dash] [Sand]** Bond Coat: on concrete or masonry surfaces, leave undisturbed, and maintain damp for at least 24 hours following installation. Dash bond coat may be omitted when liquid bonding agent is used.
  2. Scratch Coat: Install with sufficient material to completely cover laths and scratch across supports.
  3. Brown Coat: Rod to a straight, true, even within 1/4 inch tolerance in 5 feet of surface and consolidate surface with a wood or neoprene float. Surface shall be left open and coarse, suitable to receive finish coat.
  4. Stucco Finish Coat: Install in two coats to a total thickness of 1/8 inch, each coat covering surface uniformly. First coat shall completely cover basecoat with uniform color. Second color shall provide a uniform texture.
    - a. First coat shall be installed adequately to cover surface and fill minor imperfection in the brown coat.
    - b. The second coat shall be installed by doubling back same day, when first coat is sufficiently dry.
    - c. Over concrete surfaces, second coat shall be installed 24 hours after installation of first coat. In warm weather, first coat shall be cured by light water spray after material has set.
    - d. Protection: Protect those surfaces, which are not to receive dash finish coats. Such surfaces shall be shielded and shall have any sand left from dashing operation removed.
    - e. Provide smoothed plaster finish to comply with ADA requirements behind handrails.
- E. Curing Exterior Plaster: Adhere to current edition of CBC for curing requirements.
- F. Option for Machine Application, Scratch and Brown Coats: Instead of hand installed plaster, the furnishing of plastering machines for interior or exterior scratch and brown coats or single base coat is permitted. Machine installation shall be in accordance with the following:
1. Qualifications: Provide proper equipment and apparatus.
  2. Apparatus: Pump shall be equipped with an air pressure gage or factory installed blow-off valve and required safety devices. Hoses and connections shall be tight and pressure shall be maintained constant.
  3. Proportion and Application: Proportioning, mixing, number of coats and thickness shall be same as specified for hand application. Cement aggregate and water shall be mixed to plaster machine. Plaster mix shall be projected into and conveyed through a hose to the nozzle at end of hose and deposited by pressure in its final position ready for manual straightening and finishing.

4. Follow-Up: Perform scoring operation of plaster, based on settings and drying conditions at time of installation. Curing shall be as previously specified.
5. Protection: Before installing any plaster, thoroughly protect other adjacent Work.

3.07

**INTERIOR PLASTERING**

- ~~A. Portland Cement Plaster, Scratch Coat: Install to vertical lathed surfaces where ceramic tile is indicated, and install Portland cement plaster finishes where indicated.~~
- ~~B. Preparation for Plastering:~~
- ~~1. Verify that lath has been installed securely and that grounds, screeds, easing beads and other accessories are straight, in correct position, and securely fastened in place.~~
  - ~~2. Bonding Agent: Install to vertical concrete or masonry surfaces to receive ceramic tile.~~
  - ~~3. Concrete and masonry surfaces on which suction must be reduced shall be sufficiently moistened before plastering operations start.~~
  - ~~4. Install galvanized expanded metal lath on supports in conformance with requirements of ASTM C1063 and CBC.~~
- ~~C. Number of Coats and Thickness: Interior plastering to receive paint shall consist of the following, with thickness measured from face of supports or surface:~~
- ~~1. On Concrete or Masonry: two coats, brown and finish, 5/8 inch thick.~~
  - ~~2. On Metal Lath: three coats, scratch, brown and finish 7/8 inch thick.~~
- ~~D. Proportions for Interior Plaster: Adhere to current edition of CBC for proportions and curing requirements.~~
- ~~1. Admixtures shall be proportioned, mixed and installed in accordance with printed directions of manufacturer.~~
- ~~E. Mix factory blended plaster using only sufficient water to obtain proper consistency before installation. Do not mix any more material at any time than can be installed within ½ hour after mixing. Do not allow material to remain in mixer or mixing boxes overnight.~~
- ~~F. Application:~~
- ~~1. Dash Bond Coat: Dash on surface, leave undisturbed, and maintain damp at least 24 hours following installation. Omit Dash bond coat when liquid bonding agent is used.~~
  - ~~2. Scratch Coat: Install with sufficient material to form good keys, thoroughly cover lath, and cross scratch.~~

3. Brown Coat: Rod to a straight, true and even surface. Brown coat must be 1/16 inch below face of grounds to provide adequate space for finish coat. Float surface to increase density.
  4. Smooth Finishes: Install two coats for a thickness of 1/8 inch. Install second coat after finish coat begins to set. Install to a true, even plane and trowel to a smooth finish, free from blemishes.
  5. Float Finishes: Install to a thickness between 1/16 inch to 1/8 inch, install and uniformly float to true planes.
  6. Plaster Screeds: On metal lath or wire fabric lath, install plaster screeds wherever permanent grounds are too far apart to serve as guides for rodding.
- G. Curing Interior Plaster: Adhere to requirements of CBC.

#### 3.08 QUALITY CONTROL

- A. Finish interior and exterior plaster to a uniform texture, free of imperfections and flat within 1/4 inch in 5 feet. Form a suitable foundation for paint and other finishing materials. Avoid joining marks in finish coats.

#### 3.09 REPAIR OF DAMAGED PLASTER

A. Plaster Detached from Framing:

1. Remove loose and broken plaster.
2. Repair or replace damaged water-resistant backing and lath in compliance with specified standards.
3. Remove stucco finish from surrounding area in the same plane by sandblasting.
4. Install a scratch coat and a brown coat mixed with liquid bonding agent instead of water to the areas devoid of plaster.
5. Install a coat of liquid bonding agent to entire wall plane.
6. Install a 1/8 inch thick stucco finish coat to entire wall plane and match existing texture and color.

B. Cracked Plaster 1/8 inch to 1/2 inch:

1. Remove loose material from crack with a wire brush.
2. Fill crack with slurry of stucco and liquid bonding agent.
3. Install a coat of liquid bonding agent to entire wall plane.

4. Install 1/8 inch thick stucco finish to entire wall plane and match existing texture and color.
- C. Cracks Larger than  $\frac{1}{2}$  inch - Painted:
1. Remove loose material from crack with a wire brush.
  2. Fill crack with slurry of one part Portland cement to three parts masonry or stucco sand and liquid bonding agent to match existing texture of adjacent surface.
  3. Paint entire wall plane, color to match existing.
  4. Where patching of plaster over existing lath is feasible, fasten loose lath and install new lath with nails at 6 inch centers. Where metal is furnished, lap new lath over existing 6 inches and tie at 6 inch centers. Install paper backings as required, shingled into existing.
  5. Patching of Holes, Cracks, and Gouges: Holes, cracks, gouges, missing sections, and other defects in existing improvements shall be patched. For holes over 1 inch in size, cut small sections of lath and place in opening attached to existing material. Install 3 coats of plaster. For holes one inch and smaller, install bonding agent to existing surfaces and neatly fill hole with plaster, installing necessary coats to match adjacent surfaces, eliminate cracks and match existing surface texture. Cracks, gouges, and other defects shall be filled with plaster or spackle as required and neatly finished to match adjacent existing improvements.

3.10 CLEANING

- A. Remove rubbish, debris, and waste material and legally dispose of off the Project site.

3.11 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

## SECTION 09 3013

## CERAMIC TILING

## PART 1 - GENERAL

## 1.01 SUMMARY

## A. Section Includes:

1. Ceramic tile.
2. Quarry tile.
3. Waterproof membrane for tile.
4. Stone thresholds.
5. Mortar setting beds for floor and wall tile.

## B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 03 3000 - Cast-In-Place Concrete.
3. Section 06 1000 - Rough Carpentry
4. Section 07 9200 - Joint Sealants
5. Section 09 2423 - Cement Plaster and Metal Lath.

## 1.02 SUBMITTALS

- A. Product Data: Manufacturer's data, standard specifications, Material Safety Data Sheets, and other technical information for each product specified.
- B. Material Samples: Manufacturer's standard palette, indicating full range of tile colors, textures, and grout colors.
- C. Mock-Ups: For each type, color, and texture, minimum one foot square or three full tile courses, on Plexiglas to demonstrate proper bond mortar and coverage; grout color, hardness and depth.
- D. Installation Instructions: Manufacturer's preparation and installation instructions.
- E. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements of this Specification.

## 1.03        QUALITY ASSURANCE

- A. Comply with applicable parts of the following codes or standards as a minimum requirement:
1. ANSI A108, American National Standard Specifications for the Installation of Ceramic Tile.
  2. ANSI A118, American National Standard Specifications for Ceramic Tile Installation Materials.
  3. ANSI A136.1, Standard Specifications for Ceramic Tile.
  4. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
  5. ASTM C185 - Standard Test Method for Air Content of Hydraulic Cement Mortar.
  6. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
  7. ASTM C150 - Standard Specification for Portland Cement.
  8. ASTM C241 - Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic.
  9. ASTM C206 - Standard Specification for Finishing Hydrated Lime
  10. ASTM C503 - Standard Specification for Marble Dimension Stone.
  11. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members.
  12. ASTM D4551 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane.
  13. Tile Council of North America (TCNA) – Current edition of “Handbook for Ceramic Tile installation”.
  14. CHPS Low-Emitting Materials Table: Materials submitted for tile assemblies must be listed as low emitting on the CHPS website [www.CHPS.net](http://www.CHPS.net).
- B. Grade Certificate and Labeling: With each delivery of tile, furnish manufacturer's "Master Grade Certificate" to the Project Inspector.
- C. Source of Materials: Provide materials obtained from one source for each type and color of tile, grout, and setting materials.

- D. Consistent Quality: Products shall be consistent in appearance and physical properties.
- E. Comply with requirements of California Building Code and ADAAG.
- F. Qualifications of Tile Manufacturer: Company specializing in ceramic tile, mosaics, pavers, trim units, and thresholds with five years minimum experience.
- G. Qualification of Installation System Manufacturer: Company specializing in installation systems/ mortars, grouts/ adhesives with ten years minimum experience.
- H. Qualifications of Installer: Company specializing in installation of ceramic tile, mosaics, pavers, trim units and thresholds with five years experience with installations of similar scope, materials, and design.
- I. Pre-Construction Meetings: Prior to start of Work of this section and after approval of submittals, schedule an on-site meeting between Contractor, OAR, Project Inspector, and representatives of the material manufacturer and tile installer to review construction conditions and Drawings for conformance with the requirements of this Specification for each substrate.

#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver tile and other materials in sealed containers, with manufacturer's labels intact.
- B. Keep all materials clean and dry.

#### 1.05 MAINTENANCE

- A. Extra Materials: Provide a minimum of five percent of each type and color as the installed tile, in manufacturers' cartons and labeled.

#### 1.06 WARRANTY

- A. Manufacturer shall provide a five year material warranty.
- B. Installer shall provide a five year fabrication and installation warranty.
- C. For waterproofing, manufacturer shall provide a 10 year material warranty for waterproofing installation, tile setting, and grouting materials.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Tile: To establish quality, Specification is based on ANSI A137.1 Standard Grade. Equivalent tile products from the following manufacturers may be provided:

1. Dal-Tile Corporation.
  2. American Olean Company.
  3. Florida Tile, Inc.
  4. Equal.
- B. Installation Materials: To establish quality for setting and waterproofing materials, Specification is based on ANSI A137.1. Products and methods of the following manufacturers may be provided:
1. Laticrete International, Inc.
  2. Custom Building Products.
  3. Mapei.
  4. Equal.

## 2.02 MATERIALS

- A. Colors, Textures, and Patterns: Tile shall be from manufacturer's standard product line. 90 percent shall be from "price group 2", and "10 percent from price group 3", unless indicated otherwise. Tile trim and accessories shall match adjoining tile. Grout color shall match tile unless otherwise indicated.
- B. Tile sizes: Tile sizes specified are modular dimensions unless otherwise indicated.
- C. Mortar Sand: ASTM C144.
- D. Portland Cement: ASTM C 50, Type I or II.
- E. Hydrated Lime: ASTM C207, Type S; or ASTM C206 Type S
- F. Portland Cement Mortar: ANSI 118.1
- G. Portland Cement Mortar Bed: Sand-cement mortar mix gauged with Laticrete Acrylic Admix or Custom Building Products Thin-Set Mortar Admix.
- H. Portland Cement Mortar Bed for Shower Areas: Laticrete 226 Thick Bed Mortar Mix Gauged with Laticrete 3701 Mortar and Grout Admix or on site mix per ANSI A108.1A with Custom Building Products Thin-Set Mortar Admix.
- I. Latex Portland Cement Bond Mortar: Laticrete 317 Floor & Wall Thinset gauged with Laticrete 3701 Admix, or Custom Building Products Master Blend mixed with Thin-Set Mortar Admix.

- J. Waterproof Membrane: Cold-applied, single component liquid with embedded reinforcing fabric where recommended by manufacturer: Laticrete Hydro Ban Waterproof Membrane or Custom Building Products Red Guard Waterproof Membrane.
- K. Reinforcing Wire Fabric: 2-inch by 2-inch, 16 by 16 gage, galvanized electrically welded wire reinforcing, per ASTM A 185.
- L. Latex Portland Cement Grout: Laticrete Sanded Grout (1500 Series), Custom Polyblend Sanded Grout or Laticrete Unsanded Grout 1600 Series (for joints smaller than 1/8"), Custom Polyblend Unsanded Grout.
- M. Epoxy Grout for Quarry Tile: Laticrete Spectralock Pro Epoxy Grout for Floors and Walls or Custom 100 percent Solids Epoxy Grout.
- N. Cleavage Membrane and Wall Backing Paper: Cleavage membrane shall be 15-pound asphalt-saturated felt manufactured according to ASTM D226 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
- O. Separation Material (for all sealed joints including perimeters and quarry-tile fields of floor mortar beds): Quality Foam, QF 200 white, 3/8 inch wide by 5-inch high.
- P. Backer Rod for sealants (for ceramic mosaic fields): Polyethylene foam, closed-cell, flexible and compressible, 3/16 inch diameter.
- Q. Cleaner and Sealer:
  - 1. Cleaner and sealer shall be from one manufacturer, acceptable to tile and grout manufacturers. To establish quality, the Specification is based on Aqua Mix Inc. Equivalent products from Miracle Sealants Co., Watco Tile and Brick, or equal may be provided.
  - 2. Cleaner: Aqua Mix Concentrated Tile Cleaner, neutral phosphate-free cleaner, or Custom Building Products Tile Lab Concentrated Tile and Stone Cleaner.
  - 3. Sealer: Aqua Mix Penetrating Sealer, fungus- and bacteria-resistant, stain-resistant, and slip-resistant as specified for tile, Custom Building Products Tile Lab Surface Gard, or equal.
- R. Sealants:
  - 1. Sealant and primer shall be from one manufacturer, acceptable to tile and grout manufacturers. See Section 07 9200 - Joint Sealants.
  - 2. Ceramic Mosaic Tile: One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

3. Quarry Tile: Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.

## 2.03 TILE

- A. Unglazed Ceramic Mosaic Floor Tile:
  1. Size: 1 inch by 1 inch or as indicated.
  2. Colors and patterns as selected by Architect from price groups specified.
  3. Slip Resistance: Resistant to slipping appropriate to the installed conditions of use, as required by the California Building Code and ADAAG.
    - a. As a minimum, the coefficient of friction as measured by ASTM C1028 shall be 0.6 except ramps shall be 0.8.
    - b. For tile in shower and locker areas, incorporate grit into tile to increase slip resistance.
- B. Glazed Wall Tile:
  1. Size: 4-1/4 inch by 4-1/4 inch face dimensions by 5/16 inch thick (ceramic mosaic tile may also be used on walls).
  2. Colors and patterns as selected by Architect from price groups specified.
- C. ~~Unglazed Paver Tile:~~
  1. Porcelain, flat tile.
  2. Size: 12 inch by 12 inch, or as shown.
  3. Colors and patterns as selected by Architect from price groups specified.
  4. Slip Resistance: Resistant to slipping appropriate to the installed conditions of use, as required by the California Building Code and ADAAG. As a minimum, the coefficient of friction as measured by ASTM C1028 shall be 0.6 except ramps shall be 0.8.
- D. Trim:
  1. Integral bullnose at external corners.
  2. Provide bullnose where tile projects from jamb.
  3. Mosaic tile base with wall tile above: A3401.

4. Mosaic tile base without wall tile above: S3619T (6-inch high sanitary coved base).
5. Bullnose at wainscot: A4200 and A4402.

**E. Quarry Tile:**

1. Size: 6-inch by 6-inch by 1/2 inch, square edge.
2. Slip Resistance: The coefficient of friction shall be 0.6 except for ramps, which shall be 0.8, when tested in "wet conditions"
3. Kitchen Floor Color: Blaze Flash (red)
4. Non-Kitchen Floor Colors: As selected by Architect from manufacturer's standard colors.
5. Base: Trim shape Q 3565, 6-inch by 5-inch by 1/2 inch cove base, round top with integral bullnose or cove forming corners, and related trim pieces.

**F. Stone Thresholds:**

1. Exterior installation: Marble thresholds with minimum abrasive hardness value of 10 tested in accordance with ASTM C241.
2. White honed marble complying with Marble Institute of America Group "A," unless other color indicated.
3. Size and profile shaped to provide transition between tile surfaces and adjoining finished floor surfaces, or as indicated. Width not less than 4 inches. Edges beveled on a slope of no greater than 1:2. Cut to fit door frame profile.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION AND PREPARATION

- A. Examine substrates and conditions for compliance with installation requirements. Verify that all penetrations through substrate have been installed. Proceed with Work only after all conditions are in compliance.
- B. Substrates shall be firm; dry; clean and within flatness tolerances required by relevant ANSI A108 tile installation standards. Prepare surfaces as follows:
  1. Concrete Floors: Allow concrete floors to cure for 28 days minimum before beginning tile and grout installation. Remove laitance, sand, dust, and loose particles.
  2. Plywood Subfloors: Before installing mortar setting bed over plywood subfloors, install cleavage membrane over sub-floor. Anchor firmly in place and

10/01/2011

lap joints 6 inches minimum. Turn membrane up 6 inches at walls and beneath building felt on walls.

- C. Substrates to receive wall tile and base shall be:
  - 1. Scratch coat of cement plaster, as specified in Section 09 2423 - Cement Plaster and Metal Lath (required in student restrooms, showers and locker rooms, and quarry tile bases).
  - 2. Cementitious backing panels, as specified in Section 09 2900 - Gypsum Board.
- D. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical items of Work, and similar items located in or behind tile has been completed before installing tile.
- E. Verify that joints and cracks in tile substrates are coordinated with caulked-joint locations; if not coordinated, adjust as required by the Architect.
- F. Do not install tile until construction in spaces is completed and ambient temperature and humidity conditions are maintained in compliance with referenced standards and manufacturer's written instructions.
- G. Protect adjacent surfaces during progress of Work of this section.

### 3.02 TILE INSTALLATION, GENERAL

- A. Install tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Center the tile fields in both directions for each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- B. For tile mounted in sheets: Joints between tile sheets shall be the same width as joints within tile sheets.
- C. Extend Work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions, unless otherwise indicated. Terminate Work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without damaging tile. Carefully grind the cut edges of tile abutting trim, finish, or built-in items. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- E. Locate joints, directly above joints in concrete substrates, at horizontal and vertical changes in plane, or where indicated during installation of mortar beds. In quarry tile floors, provide at 12 feet on center maximum. Provide 3/8-inch wide foam at joints. Do not saw-cut joints after installing tiles.

- F. Prepare and clean joints to be sealed. Apply sealants to comply with requirements of Section 07 9200 - Joint Sealants.
- G. Conform to manufacturers printed instructions, and applicable requirements of ANSI and TCNA Standards.

3.03 ~~TILE INSTALLATION, FLOOR~~

- A. ~~Install reinforcing and latex Portland-cement mortar setting bed over cured concrete slab or cleavage membrane on plywood floor. Lap reinforcing at least one full mesh, and support or lift so that it is approximately in the middle of mortar bed. Do not abut against vertical surfaces. Install foam separation material at perimeters and expansion joint locations for caulked joints.~~
- B. ~~Mix setting mortar in accordance with ANSI recommendations.~~
- C. ~~Once begun, mortar installation must continue until room is completed. Discard any batch not floated and finished within  $\frac{1}{2}$  hour of mixing. Firmly compact before screeding. Screeed to true plane and pitch as indicated. Slope mortar bed sufficiently that water flows to drain and no puddling will occur. Slope mortar down to floor drains for proper installation of waterproof membrane. After screeding, firmly rub down with steel or wood float.~~
- D. ~~Cure mortar bed with a light fog spray of water and cover with 6-mil Visqueen for 72 hours.~~
- E. ~~Waterproof Membrane:
  1. Install waterproof membrane where indicated and in all kitchen, toilet, shower, and locker areas according to TCNA Standards. Extend membrane up wall mortar or backing board as follows:
    - a. 3 inches above top of curb wall.
    - b. 6 inches minimum above floor.
    - c. In shower rooms, install from floor to ceiling.
  2. Insure that layers of membrane are fully inserted into clamping ring of floor drain. After membrane installation and before tile setting, install pea gravel around sub drain to prevent blockage of weep holes and place mortar to proper level for setting tile.
  3. For tile installations other than slab on grade, before setting tile and after seven days curing, water test membrane by damming drains and doors, filling floor with water to 4-inch minimum depth, and leaving for 24 hours. Correct any leaks and re-test before proceeding. After testing, protect membrane from traffic until tile work begins.~~

10/01/2011

CERAMIC TILING  
09 3013-9

- F. Thin Set Method: Confirm substrate is completely clean and free of dust. Cut foam at floor perimeters flush with top of mortar bed. Insure that bond coats do not intrude into joints to be sealed. Install tile over properly cured setting bed or waterproof membrane utilizing "thin-set" method with latex portland cement bond mortar, in accordance with manufacturer's printed instructions and ANSI A108.5.
- G. Minimum coverage of bond mortar shall be 80 percent except 95 percent in shower areas, for quarry tile, and exterior installations. Place tile into fresh mortar press tile to insure full contact. Before setting proceeds, set and remove three tiles or sheets of tiles to confirm specified coverage of bond mortar. If coverage is insufficient, utilize a larger toothed trowel or back butter tiles until proper coverage is provided.
- H. Install tile on floors with the following joint widths:
1. Ceramic Mosaic Tile: 1/16 to 1/8 inch.
  2. Quarry Tile: 1/4 to 3/8 inch.
  3. Paver Tile: 3/16 to 3/8 inch.
- I. Install base tile for quarry tile floors on a mortar bed, with joints matching floor.

### 3.04 TILE INSTALLATION, WALLS

- A. Install wall mortar beds before floor mortar beds.
- B. On plaster walls, clean scratch coat surface of loose or foreign materials, fog spray with water, and install brown coat mortar bed over scratch coat to a thickness not less than 3/8 inch and not greater than 3/4 inch. Once started, wall mortar installation must continue until wall is completely floated. Discard any batch not floated and finished within 1/2 hour of mixing. As soon as wall mortar is dried to sufficient hardness, but still plastic, firmly rub with wood float.
- C. Cover cure with 40-weight Kraft paper for 72 hours minimum.
- D. Install tile over properly cured setting bed, waterproof membrane, or cementitious backing panels utilizing "thin-set" method with latex portland cement bond mortar, in accordance with manufacturer's printed instructions and ANSI A108.5. Confirm substrate is completely clean and free of dust. Insure that bond coats do not intrude into joints to be caulked.
- E. Minimum coverage of bond mortar shall be 80 percent except 95 percent in shower areas or exterior installations. Set and test as specified for floors.
- F. Lay out Work so tiles will be centered on each wall or section of wall in order to minimize tile cuts. Lay out tile wainscots to next full tile beyond dimensions indicated. Spot setting bed with mortared tile, set plumb and true, accurately indicate plane of finished tile surfaces.

- G. Install tile on walls with following joint widths:
  - 1. Glazed Wall Tile: 1/16 inch.
  - 2. Ceramic Mosaic Tile: 1/16 to 1/8 inch.
  - 3. Quarry Tile: 1/4 to 3/8 inch.
  - 4. Special Large Tile: 3/16 to 3/8 inch.
- H. Horizontal joints shall be level, vertical joints plumb with surfaces true and plumb, edges of tiles flushed.
- I. Rub exposed cuts smooth with a fine stone; no cut edge shall be set against a fixture or adjoining surface without a 1/16 inch joint to be caulked.
- J. Install access doors where required, furnished under another section, in correct location, plumb or level, flush with adjacent construction, and securely fastened to framing.

## 3.05

## GROUTING

- A. Prior to starting, ensure that all tile surfaces are clean and excessive bond mortar is scraped and vacuumed from joints (approximately 2/3 depth of tile should be open for grouting). Follow manufacturer's instructions for mixing grout. Once grout Work commences, proceed until complete wall or floor area is finished utilizing one batch of grout.
- B. Latex portland cement grouting: Dampen tile surface and joints with water using sponge, but leaving no puddles in joints. Force grout into joints using sufficient pressure on rubber float so as to fill joints completely, and scrape excess grout off tile surface with rubber float. Smooth or tool grout to uniform joint finish. Do not over water.
- C. Curing latex Portland cement grout: Remove final grout haze with clean soft cloth, and cover with 40-weight Kraft paper to cure. Leave paper in place for protection. Cover wall surfaces with 40-weight Kraft paper for 72 hours.
- D. Epoxy grouting: Do not dampen tile. Follow manufacturer's instructions for mixing grout. Force grout into joints with sufficient pressure on rubber float so as to fill joints completely, and scrape excess grout off tile surface with rubber float. Smooth or tool grout to uniform joint finish. Do not allow grout to harden on face of tile.
- E. Curing epoxy grout: Do not cover floor, but do not allow foot traffic for 72 hours. Then, if grout is not tacky, cover with 40-weight Kraft paper for protection.

## 3.06

## CLEANING AND SEALING

- A. If grout scum is not visible on tile surface after curing, clean tile surface with clear water. Remove and replace cracked, broken or defective Work with proper material.

- B. If, when curing membrane is removed, grout scum is visible on tile surface, use the following cleaning method:
  1. Immediately recover floor with paper or felt and allow to continue curing for a minimum of 14 days; uncover floor and maintain entire tile surface saturated with clean cool water for not less than two hours.
  2. Utilize a neutral cleaner acceptable to manufacturers of tile and grout, and follow manufacturer's instruction. Do not provide generic acid cleaners.
  3. Wet tile floors and apply cleaning solution to floor surface, then scrub with a brush. Rinse area several times with clean water to flush solution off floor surface.
- C. Apply penetrating sealer in accordance with manufacturer's instructions utilizing a dense sponge applicator, paint pad, sprayer or brush. Avoid overlapping, puddling, and rundown. Completely wipe surface dry within 3 to 5 minutes using cotton or paper towels; do not allow sealer to dry on tile. After two hours, test surface by applying water droplets to surface. If water is absorbed, apply a second coat. Avoid surface traffic for 24 hours.

#### 3.06 SEALANTS

- A. Insure joints to be sealed are free of setting and grouting materials and construction debris. Do not permit any foot traffic on installed sealants for a minimum of 48 hours or protect with hardboard strips.
- B. Install in accordance with Section 07 9200 - Joint Sealants.

#### 3.07 PROTECTION

- A. Admit no traffic where tile is installed until mortar and grout has set for a minimum of 72 hours.
- B. Protect Work of this section until Substantial Completion.

#### 3.08 CLEAN UP

- A. Remove rubbish, debris, and waste material and legally dispose of off the Project site.

END OF SECTION

## SECTION 22 0513

## BASIC PLUMBING MATERIALS AND METHODS

## PART 1 – GENERAL

## 1.01 SUMMARY

## A. Section Includes:

1. This Section prescribes basic materials and methods generally common to the Work of Division 22.

## B. Related Requirements:

1. Division 01: General Requirements.
2. Division 22: Plumbing.
3. Division 26: Electrical.

## 1.02 SUBMITTALS

- A. Provide in accordance with Division 01, Section 22 0500 and specific requirements of each section of Division 22.
- B. Types of welding rods to be used.

## 1.03 QUALITY ASSURANCE

- A. Standards: Comply with applicable national, state, and local codes and standards: ASTM, ASME, and ANSI. Federal Specifications, AWWA, SISPI, NFPA, FM, UL, CPC (California Plumbing Code), CMC (California Plumbing Code), CSA.
- B. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production as reviewed by the Architect.

## 1.04 COORDINATION

- A. Coordinate related Work in accordance with provisions of Section 01 3113: Project Coordination.

## PART 2 – PRODUCTS

## 2.01 GENERAL

- A. Provide the following products if they are indicated in the Contract Documents or if they are required for the proper installation, function or operation of equipment, systems or components indicated in the Contract Document.
- B. Provide the following products as a complete assembly with required accessories for a complete and functioning entity in compliance with governing codes and applicable standards as specified in Section 22 0500, manufacturer's instructions or as required.
  - I. Omission of minor details in the Contract Documents does not waive and/or otherwise relinquish compliance with the above requirements.

## 2.02 MANUFACTURERS AND MATERIALS

- A. Ball Valves: Bronze, 2-inch and smaller:

BV-1: Class 150, 600 psi, CWP, 2 piece construction reinforced Teflon seats, full port, adjustable packing gland, stainless ball and stem, threaded ends.

Hammond UP-8303A/UP-8305/UP-8513, NIBCO T-685-80-LF/TS-685-66-LF, Milwaukee UPBA400S/450S, or equal.

BV-2: Class 150, 600 psi, CWP two piece construction with reinforced TFE seats, full port, adjustable packing gland, (no threaded stem designs allowed), threaded ends.

NIBCO T-685-80-LF, Hammond UP-8303A, Milwaukee UPBA-400 or equal.

NIBCO T585 S6R66 (Stainless Steel), Milwaukee BA-260 (Stainless Steel).

BV-3 Class 150, 600 psi CWP, 2-piece construction, bronze body, reinforced Teflon seats, adjustable packing gland, (no threaded stem designs allowed), threaded ends.

Hammond UP8301A, NIBCO T-585-70, Milwaukee BA-400, or equal.

Ball Valves in Insulated Piping: Use extended operating handle of non-thermal conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied. NIBCO Nib-Seal Handle.

- B. Butterfly Valves:

BFV-1 Centerline Series A, 200 psi CWP tight shut-off.

1. Body: Lug type ductile iron. Suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
2. Disc: Bronze, or aluminum bronze.

3. Stem: One or two-piece, 400 series stainless steel.
4. Seat and O-Rings: EPDM.
5. Upper and Lower Stem Bearings: Copper alloy or non-metallic material.
6. Operators: Valves 6 inches and smaller, with lever handle. Valves 8 inches and larger, with manual gear operator and disc position indicator.
7. Manufacturers:
  - a) Valves 2.5 to 6-inch: NIBCO, Milwaukee ML-233E, Hammond 6411-03, or equal.
  - b) Valves 8-inch and larger: Milwaukee ML 333E, Hammond 6411-03, NIBCO LD 2000, or equal.

C. Check Valves:

1. Bronze, 2-inch and smaller:

CHV-1: 200 psi, CWP horizontal swing, Y pattern, renewable seat and disc, threaded ends.

NIBCO T-413-Y-LF, Milwaukee UP-509, Hammond UP-904 or equal.

CHV-2: Class 125 200 psi, swing check, bronze body, Teflon disc, soldered ends.

Stockham B-310TY, Crane 1340, NIBCO S-413-Y, Milwaukee 1509-T, Hammond IB-912 or equal.

CHV-3: 200 psi, CWP, bronze body, horizontal swing, Y pattern, renewable seat and disc, solder ends.

Nibco S-413-Y-LF, Milwaukee UP 1509-T, Hammond Up-946 or equal.

2. Cast Iron 2 1/2-inch and larger:

CHV-4: Class 125, 200 psi, CWP, IBBM, renewable seat and disc, bolted cap, threaded ends:

Crane 372, Stockham G-927, NIBCO T-918-B, or equal.

CHV-5: Special low-pressure check valve for installation in gas lines.

Circle Seal Products Co.

119B-PP-0-15 psi; #1:1/8 inch IPS; #2:1/4 inch IPS #3:3/8 inch IPS.

D. Earthquake Valve:

EQV-1 Mechanically triggered by seismic movement, complying with state of California seismic response specifications, UL listed and certified by D.S.A. Size and pressure as required or indicated on Drawings. (Minimum 1/4 psi, maximum 10 psi. Earthquake valve shall shut off gas automatically during an earthquake to prevent an explosion or fire. Valve shall be Koso California seismic valve, or equal.

1. Not sensitive to vibrations caused by passing trucks or accidental bumping.
2. Sensitive to wide amplitude G's only. Preset at factory for the correct G-rating.
3. Positive sealing from minus 10 degrees F. to 150 degrees F.
4. Visual open-close indicator.
5. Manual reset.
6. Plumb line for mounting.
7. Tripping mechanism has non-creeping rolling latch.
8. Install valve per manufacturer's recommendations only.

D. NOT USED

E. Flow Control Valve – Manual:

FC-1 Flow control valves: Bell and Gossett Series CB circuit setter balancing valve, line size, with integral pointer (to register degree of valve opening), differential pressure meter connections with built-in check valves and lockable memory stops. Armstrong Series CBV circuit-balancing valves, Victaulic/TA Hydronics, or equal.

F. Gate Valves:

1. Bronze, 2-inch and smaller:

GV-1 Class 125, 200 psi CWP, bronze body and bonnet non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Hammond IB645, Crane 1701, Milwaukee 105, American 3F, NIBCO T-113, or equal.

GV-2 Class 125, 200 psi, CWP, bronze body and bonnet, non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

NIBCO T-113-LF, Milwaukee UP 105, Hammond UP 645 or equal.

GV-3 Same as GV-1, except solder ends:

NIBCO S 113, Milwaukee 115, Hammond IB 647, or equal.

GV-4 Class 125, 200 psi, CWP, bronze body and bonnet, non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

NIBCO T-113-LF, Milwaukee UP 105, Hammond UP 645 or equal.

GV-5 Class 125, 200 psi WOG, rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Stockham B-100, Crane 428, NIBCO T-111, Milwaukee 148, Hammond IB-640, or equal.

GV-8A Class 250, 250 psi, CWP, O S and Y, IBBM, resilient seat gate valve, flanged ends.

Watts 408-OSY-RW, Kennedy 7168 or equal.

The epoxy coated valves are recommended in the domestic cold water system where corrosives in the water line might cause damage to the inside of valve and where pressure rating in excess of 200 psi is required.

GV-9 Class 125 250 psi CWP iron body, flanged ends, bolted bonnet with wheel handle, resilient wedge, non-rising stem.

NIBCO F-619-RW or equal.

GV-10 Class 125, 250 psi CWP iron body, flanged ends, bolted bonnet with 2-inch operating nut, resilient wedge, non-rising stem, fusion bonded epoxy coated.

NIBCO F-619-RW-SON or equal.

G. Globe Valves:

1. Bronze, 2-inch and smaller:

GLV-1A Class 125, 200 psi, CWP, screw-in bonnet, Teflon disc, threaded ends:

Milwaukee UP 502, Hammond UP 440 or equal.

GGLV-2 Class 125, 200 psi, CWP, screw in bonnet, Teflon disc, solder ends.

Hammond IB-418, Milwaukee 1502, NIBCO S-211-Y, or equal.

GLV-2A: Class 125, 200 psi, CWP, screw in bonnet, Teflon disc, soldered ends.

Milwaukee UP 1502, Hammond UP 418 or equal.

H. Heater Vent Pipe:

1. Schedule Number:

HVP-1 Shall be UL approved for service specified. Concealed heater vent pipe, including pipe in or through attic spaces, shall be Los Angeles City approved double wall metal vent pipe. For recessed wall heaters, furnish B.W. type. All others may be Type B, or B.W. Clearances must comply with Los Angeles City code and conditions of UL listing.

American Metal Products Co., Inc., Simpson Dura-Vent, AmeriVent, Hart & Cooley Mfg. Co., Metalbestos, or equal.

I. Liquid Level Gage:

LLG-1 Refrigerant type, carbon steel with stainless steel trim or all forged steel construction, back-seating standard design. Upper and lower valve furnished with ball check valves; 1/2 inch diameter glass on center. Four 3/16 inch diameter gage glass guard rods or slotted steel guard.

Peneberthy, Henry, Conbraco, or equal.

Magnetic Lever Valves:

MLV-1 Bronze, stainless steel and bronze trim, 2-way, packless normally closed, metal seat.

General Controls, K-10AA2030 or equal.

K. Piping:

1. Piping shall be continuously and permanently marked with manufacturer's name, type of material, size, pressure rating, and the applicable ASTM, ANSI, UL, or NSF listing. On plastic pipe, date of extrusion must also be marked.

2. Underground non-ferrous pressure pipes shall be installed with proper color tracer wires. Refer to color code provisions in Section 22 0553: Plumbing Identification.
- P-1 Cast iron: Hubless, service weight, ASTM A888, CISPI 301, conforming to CISPI 310 and installed in accordance to IAPMO 1S 06. American Foundry, Tyler, or AB & I or equal.
- P-2 Galvanized steel, Schedule 40, ASTM A53., US Steel or equal.
- P-3 Copper drainage tube, underground, type L hard, ASTM B 88, Mueller, Cerro Brass or equal.
- P-4 Copper drainage tube, inside structure and above grade. Type DWV hard temper, ASTM B 306, Mueller, Anaconda, Cerro Brass, Cambridge-Lee, Halstead or equal.
- P-5 Purple pipe, PVC, schedule 40 for reclaimed or recycled water (below ground only for non-potable irrigation systems), type 1, grade 1, PVC-1120, Cell Class 12454 B.
- P-6 Copper water tube, Type L hard, ASTM B88. Mueller, Cambridge-Lee, Halstead or equal. (when used above ground only)
- P-7 Copper water tube, Type K hard, ASTM B88, by Mueller, Cerro Brass, Cambridge-Lee, Halstead or equal.
- P-8 Polyethylene plastic pipe, ASTM D 2513, standard dimension ratio. 11, rated at 80 psi working pressure at 73 degrees Fahrenheit (F). for 3-inch and smaller, SDR 11.5 rated at 76 psi at 73 degrees F. for 4-inch and above, butt or socket type fittings, joined by heat fusion, orange or yellow color.  
CPCHEM (Chevron Phillips Chemical Company LP) PE 2406, or equal.
- P-9 Red seamless brass 85-5-5-5, iron pipe size (IPS), threaded pipe, ASTM B43. Mueller, Cerro Brass, Cambridge-Lee, Halstead or equal.
- P-10 Black steel pipe, Schedule 40, ASTM A53, Type E, ERW by US Steel, or equal.
- P-11 Seamless copper tubing, tempered drawn, Type M, ASTM B88 by Mueller, Cerro Brass or equal.

- P-12 High Silicon Iron Casting, 1 ½-inch and 2-inch, threaded for science room vents when ferrous waste piping is provided, ANSI-A21.10, WWP-356-36, ASTM D1784-699, by Duriron or equal.
- P-13 PVDF (Polyvinylidene Fluoride) schedule 40 pipes, conforming to ASTM F1673, ASTM D3222 and complying with UL723 (ASTM E84). The joints may be no-hub or electro-fusion type. Installer shall be certified by manufacturer for joint installation. Orion, Fuseal or equal.
- P-14 Polypropylene chemical waste, flame retardant pipe, conforming to ASTM F1412 and ASTM D4101. The joints may be no-hub or electro-fusion type. Installer shall be certified by the manufacturer for joint installation. Orion, Fuseal or equal.
- P-15 PVC, thick wall, cast-iron OD sized, UL listed, AWWA listed, NSF listed, Class 200 with tracer wire, Blue Brute, or equal.
- P-16 Type 316L Stainless steel chemical waste pipe, marked with manufacturer's identification and fittings. Mechanical press fit joints with EPDM seals. Manufacturer's representative shall instruct installers and certify them for joint installation. Piping system shall be provided with a five-year manufacturer's material warranty.

Blucher-Josam or equal.

- P-17 304 / 304L Stainless Steel, .049 wall, ASTM A312. Pipe must be certified for use with the Vic-Press 304TM piping system, by Trent Tube, Victaulic or equal.
- P-18 CPVC (Chlorinated polyvinyl Chloride) schedule 40 pipe, conforming to ASTM D1784 and complying with UL723 (ASTM E84). The joints shall be of solvent cement type conforming to ASTM F493. Installer shall be certified by the manufacturer for this type of joint installation. Spears, Corzan, Charlotte or equal.
- P-19 PVC, schedule 40, extruded from 100 percent virgin Polyvinyl Chloride (PVC) compound, meeting requirements of class 1254-13 of ASTM D1784.

#### L. Pipe Fittings:

- PF-1 Cast iron, soil or waste no-hub coupling with neoprene gaskets, stainless steel corrugated shields and stainless steel clamps. 2 bands for size 1 ½-inch thru 4-inch, IAPMO, ASTM C 564 and CISPI 310.

- American Foundry, Mission, Tyler, or equal.
- PF-2 Cast iron, soil or waste, Heavy-duty no-hub coupling with neoprene gaskets, stainless steel corrugated shields and stainless steel clamps. 4 bands for size 5-inch thru 10-inch. IAPMO, ASTM C564 and CISPI 310.  
American Foundry, Mission, Tyler, or equal.
- PF-3 Malleable iron, Class 150, threaded, galvanized, beaded, ANSI B 16.3. P-2  
Stockham, Stanley Flagg, Grinnell Oreual.
- PF-4 Cast brass drainage fittings ASA B 16.23, ASTM B 42. Provide with copper drainage tube.  
Mueller Brass, Nibco, Stanley Flagg, Lee Brass Or equal.
- PF-5 Wrought copper - solder type ANSI B 16.22  
Mueller Brass, Nibco, Lee Brass or equal.
- PF-6 Polyethylene plastic fittings, ASTM D 3261 and D 2683, standard dimension ratio 11, rated at 80 psi working pressure at 73 degrees F. for 3 inches and smaller, SDR 11.5 rated at 76 psi at 73 degrees F. for 4 inches and above, butt or socket type fittings, joined by heat fusion, color orange or yellow.  
CPCHEM, (Chevron Phillips Chemical Company LP) or equal.
- PF-7 Polyethylene transition risers, for Pff-6 above, Transition fitting must have a minimum vertical height of 36 inches from the horizontal connection which will allow for a 6-inch steel riser above ground. Polyethylene transition risers shall be anodeless.  
Central Plastics Company or equal.
- PF-8 Bronze and brass, 250 psi, threaded, ASA B16.17 and F S WW-P-460.  
Mueller Brass, Lee Brass Or equal.
- PF-9 Malleable iron, Class 125, ANSI B 16.3, threaded or welded Schedule 40 black steel for 2-inches and below and welded for 2 ½-inch and above, by Stockham or equal.
- PF-10 Cast iron, threaded, Class 125, ANSI B 16.1.  
Stockham or equal.

PF-11 Cast-iron OD sized,, bell and spigot gasket joints.

PF-12 Steel butt weld type, ASTM A 234WPB.

PF-13a No-hub couplings for factory grooved PVDF or polypropylene, schedule 40 piping. The coupling shall be of the same material and gauge as the pipe. Each coupling shall have 300 series stainless steel outer band and 5/16 inch bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. Installer shall be certified by the manufacturer for this type of joint installation. Orion, Fuseal or equal.

PF-13b The pipe and fitting shall be joined using the socket fusion system conforming to ASTM 2657. Installer shall be certified by the manufacturer for this kind of joint installation. Orion, Fuseal or equal.

PF-13c CPVC (Chlorinated Polyvinyl Chloride) schedule 40 pipe and fittings, conforming to ASTM D1784 and complying with UL723 (ASTM E84), shall be joined using solvent cement conforming to ASTM F493. Installer shall be certified by the manufacturer for this kind of joint installation. Spears, Corzan or equal.

PF-14a Drains, bottle traps and similar devices for CPVC, PVDF or polypropylene, schedule 40 piping, shall be of same material and gauge as the pipe with mechanical joints. Installer shall be certified by the manufacturer for this kind of joint installation. Orion, Fuseal or equal.

PF-14b Type 316L Stainless steel joint for chemical waste piping systems including drain or bottle traps. Blucher-Josam or equal.

Victaulic Vic Press 304TM or equal.

PF-15 Precision cold drawn austenitic 304/304L stainless steel, with elastomer O-rings

PF-16 Grooved end type- ASTM A395 and A536 ductile iron; ASTM A234 WPB forged steel; fabricated from ASTM A53 carbon steel. Couplings shall be supplied with angle-pattern bolt pads for rigidity, except in locations where flexibility is desired. Gaskets shall be pre-lubricated. Galvanized or painted, by Victaulic or equal.

PF-17 Grooved end type- ASTM B75 or B152 and ANSI B16.22 wrought copper, bronze sand casting per ASTM B584-87 copper alloy CDA 836 per ANSIbB16.18. Couplings shall be CTS style 606 supplied with angle pattern bolt pads for rigidity, coated with copper coated alkyd enamel. Gaskets shall be pre-lubricated Flush seal type by Victaulic or equal.

PF-18 CPVC fittings must conform to ASTM D2846 specification for chlorinated polyvinylchloride (CPVC) plastic for hot and cold water distribution system.

PF-19 Plastic fittings, schedule 40 molded from PVC type I compound, conforming to the requirements of specification ASTM D2466.

M. Pipe Isolators:

PLA-1 Absorption pad shall be not less than  $\frac{1}{2}$  inch thick, unloaded. Pad shall completely encompass pipe.

Holdrite, LSP, Stoneman, Potter-Roemer, Trisolator, PR-Isolator, or equal.

Hydra-Zorb Cushion Clamps, Acousto-Clamp, or equal.

N. Pressure Gage: Aluminum or steel case, minimum 4  $\frac{1}{4}$ -inch dial; pressure type or combination vacuum-pressure type, with provisions for field calibration. Dial indicator to indicate pressure in psi with accuracy to within plus or minus 0.5 percent of maximum dial reading. Furnish gages with restriction screw, size 60, to eliminate vibration impulses. Black case and ring, bourdon tube of seamless copper alloy with brass tip and socket. Three way gage cock, constructed of brass with stuffing box, 1/2 inch couplings, with fixed or movable cap nut to shut off pressure gage.

PG-1 Pressure type, black drawn steel case, 4-1/2-inch glass dial, range approximately twice line pressure.

Marsh Keckley, Trerice, Weksler, Weiss, or equal.

O. Plug Valves:

PV-1 2 inches and smaller: Rockwell No.114, lubricated plug type, 200-pound., water operating gauge pressure iron body and plug, regular pattern, threaded, with indicating arc; by Walworth, Homestead, WKM, or equal.

PV-2. 2  $\frac{1}{2}$ -inch and larger: Rockwell No.115 and No.165 lubricated plug type, 200 pound water operating gauge. Iron body and plug, regular pattern, flanged, with indicating arc. Walworth, Homestead, WKM, or equal.

P. Safety Relief Valves:

SRV-1 Combination temperature and pressure relief type. CSA approved. Set to open at 125 psi pressure.

Watts 40L      Cash-Acme NCLX-1

SRV-2 Same as SRV-1, except provide on storage type water heater with anode in dip tube.

Watts 10 x L, Cash-Acme NCLX-1

SRV-3 Spring type, ASME and NB stamped and certified with manual lifting device for air or gas.

Bailey, Cash-Acme, Watts, Keckley or equal.

**Q. Strainers:**

STR-1 Description: Wye type with monel or stainless steel strainer cylinder (manufacturer's standard mesh), and gasketed machine strainer cap. Where indicated on Drawings, provide with valved (globe valve) blowout piping, same size as blowout plug.

1. 2-inch and smaller:

C.M. Bailey No.100-A, 250 lb., cast iron body, threaded, Keckley 'B', Spirax Sarco Y-type, or equal.

2. 2 ½-inch and larger:

C.M. Bailey No.100-A, 125 lb., cast iron body, flanged, or Victaulic style 732, 300 psi, ductile iron body, grooved, fusion bonded epoxy coated.

C.M.Bailey, Armstrong, Muessco, Keckley 'A', or equal.

STR-2 Y pattern cast iron bodies, 125 psi, monel screen. Open area at least twice the cross-sectional area of IPS pipe in which strainer is installed and may be woven wire or perforated type. Screwed ends for sizes up to 2 inches, flanged ends fusion bonded epoxy coated for 2 ½-inch and larger perforations, in accordance with the following:

1. Steam service - 40 square mesh.

2. Other services - 16 square mesh.

Bailey No.100, Armstrong, RP&C, Keckley or equal.

STR-3 Flanged, bucket type, semi-steel body, 125 psi, stainless steel screen with 1/8 inch diameter perforations, all sizes.

Bailey No.1, Zurn 150 Series, RP&C, Keckley GFV or equal.

STR-4 Grooved, T-pattern, ductile iron body, 300 psi, stainless steel frame and mesh basket, grooved ends.

**R. Vent Caps:**

VC-1 Vandal-proof hood type, for plumbing vent lines.

Stoneman Engineering and Mfg., Semco 1550

S. Vacuum Valves:

VV-1 Vacuum valves; for vacuum serve, 125 psig working pressure, cast iron body, spring loaded lubricated plug type.

General Controls, Honeywell, Valmatic, or equal.

T. Protective Coating for Underground Steel Piping Applied to Underground Automotive:

VV-1 Vacuum valves; for vacuum service, 125 psig

1. Black steel or galvanized steel piping indicated for below grade installation, shall be protected as specified prior to delivery to the Project site:
  - a. Sandblast black steel pipe to a gray finish. Sandblast galvanized steel pipe lightly only.
  - b. Install one coat of cut back asphalt to galvanized pipe immediately after sandblasting. Pre-heat black pipe to 180 degrees F. immediately before coating.
  - c. Install one coat of high-temperature (melting point of 240 degrees F. minimum) Grade B asphalt enamel.
  - d. Install one wrapping of 20 mils thick glass, fiber mat, Owens-Corning Coromat or L.O.F. Blueflag with 1/4 inch overwrap. Glass fiber shall be dry at time of installation.
  - e. Install a second coat of asphalt enamel as specified above. Glass fiber mat shall be centered in the asphalt enamel.
  - f. Install an overwrap of Kraft ripple paper.
2. Total thickness of pipe wrapping shall be not less than 1/8 inch. Entire coating operation shall be accomplished by mechanical means in a continuous operation. Hand installation of protective coating is not permitted.
3. Each piece of wrapped pipe shall be legibly identified at no greater than 5 feet intervals by fabrication company. Each material submittal shall include the name of the fabrication company. Maintain one reviewed Sample on the Project Site.
4. Acceptable manufacturers of wrapping are: Hunt, Mobile, Conway or equal.

5. Fittings (including couplings), unprotected pipe adjacent to fittings, and damaged pipe protection shall be wrapped at Project site as follows:
  - a. Fittings and pipe to be wrapped shall be thoroughly cleaned of material foreign to pipe manufacturer.
  - b. Install one coat of Plicoflex No. 105 or Protecto Wrap No. 1170 adhesive primer to metal.
  - c. Wrap pipe and fittings with a minimum thickness of 3/32 inch of Plicoflex No. 310 pipe line butyl molding tape, or Protecto Wrap No. 200 molding tape. Install 3 layers, each layer overlapping next approximately 2/3 width of tape, without stretching. Tape and primer shall be of the same manufacturer.
  - d. Wrap vinyl tape, 10 mil thickness, over molding tape with 1 inch minimum overlap.  
J.M. Trantex, 3M Scotchwrap or equal.
5. Pipe and fittings specified to be wrapped shall be tested with a holiday detector, after pipe has been installed in trench and before backfilling, in presence of the Project Inspector. Furnish a Tinkler and Raser model E-P holiday detector, or similar equipment for this test. Work, which is deemed defective, shall be repaired or replaced. The Project Inspector may test for damaged pipe wrapping after backfilling.
6. Instead of wrapping underground steel pipe as specified above, pipe may be machine-wrapped before delivery to the Project site as follows:
  - a. Pipe shall be cleaned of moisture, oil, grease, scale, and other foreign material by cleaning with non-oily solvent and wire brushing. Remove metal burrs and projections.
  - b. Install one coat of Plicoflex No.105 adhesive primer to cleaned pipe. If thinning is required, furnish only non-oily thinners as recommended by tape manufacturer.
  - c. Wrap coated pipe with Plicoflex No.340-25 tape (15 mil butyl and 10 mil vinyl laminate) Tape shall be installed by machine wrapping at approved plant only. Maintain tension (minimum of 5 pounds per inch of width) on tape over entire diameter of pipe. Tape shall be permanently identified and visible on vinyl side.
  - d. Fittings, unprotected pipe, and damaged pipe protection shall be wrapped as indicated above.

U. Pipe and Fitting Requirements Schedule: Unless otherwise specified or indicated on Drawings, pipe and fittings shall be installed in accordance with the following table:

TABLE I  
PIPE AND FITTING SCHEDULE

Use	Limits	Pipe	Fittings
Domestic Hot and Cold water, underground	Up To 8 inches	P-6	PF-5
Copper, underground only		P-7	PF-5
Cold water, underground (Site piping)	4-inch and over	P-15	PF-11
Domestic hot and cold water, in building and above ground	All	P-6	PF-5
In building above ground	2 to 8-inch	P-6	PF-5
Compressed air	Underground or in concrete	P-9	PF-8
	Above ground	P-10	PF-3
Condensate drains and drains From HVAC Equip.		P-6	PF-5
Downspouts, interior above and below grade, up to 5 feet from building.		P-1	PF-1 Or PF-2
Acid Vent	All	P-12	PF-10
Fire Mains (Fire Hydrant)	Underground	P-15	PF-11
Gas Natural	Underground	P-8	PF-6
Gas Natural	Above ground	P-10	PF-9
Copper Drainage Tube (Underground)	Waste and Vent	P-3	PF-4
Copper Drainage Tube (Above Ground)	Waste and Vent	P-4	PF-4
Vents	New Building	P-1	PF-1 or PF-2 (IRE) if required by engineer
Vents	Existing Buildings and Exposed Downspouts	P-2	PF-3
Vents	For acid waste lines underground	P-13, 14, 16, 17, 18	PF- 13a, 13b, 13c, 14a, 14b or 15
Waste lines, Sanitary		P-1	PF-1 or PF-2 (IRE) if required by engineer
Waste lines, Acid	To nearest water dilution jet	P-13, 14, 16, 17, 18	PF- 13a, 13b, 13c, 14a, 14b or 15

V. Flanges: Flanges shall be furnished and installed at each flanged connection of each type of equipment, tanks, and valves. Faces of flanges being connected shall be furnished alike. Connection of a raised face flange to a flat-faced flange is not permitted. Flanges shall conform to following schedules:

TYPE OF PIPE	FLANGE
Screwed black or galvanized grooved steel pipelines.	125 pound black cast iron screwed flange, flat faced or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, Gruvlok Fig. 7401, or equal.
Welded or grooved steel pipe, except high pressure steam lines.	150 pound black forged steel welding flanges, 1/16 inch raised face ASTM A 105, Grade II or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, Gruvlok Fig. 7401, or equal.
Copper and brass pipe or tubing.	150 pound cast bronze, flat-faced flange with solder end or grooved flange adapters, Victaulic Style 641, Tyco-Grinnell Fig. 61, Gruvlok Fig. 6084, or equal.

1. Gasket material for flanged connections shall be full faced or ring type to suit facing on flanges and shall be furnished in accordance with following schedule

<u>SERVICE</u>	<u>TYPE</u>
Cold water	1/16 inch thick neoprene

Grooved end flange adapters supplied with pressure responsive elastomeric Gaskets supplied with grooved flange adapters shall be pre-lubricated by the manufacturer. Grade of gasket to suit intended service.

W. Unions:

1. Unions shall be furnished and installed in accordance with the following requirements (unless flanges are furnished):
- a. At each threaded or soldered connection to equipment and tanks, except in Freon or fuel gas, piping systems, whether indicated or not.
  - b. Immediately downstream of any threaded connection to each manually operated threaded valve or cock, and each threaded check valve, yard box or access box except those in Freon piping systems, whether indicated or not.
  - c. At each threaded connection to threaded automatic valves (except those in Freon piping systems) such as reducing valves and temperature control valves, whether indicated or not.
  - d. If grooved piping is used, couplings shall serve as unions. Additional unions are not required

2. Unions shall be located so that piping can be easily disconnected for removal of equipment, tank, or valve.

## PART 3 – EXECUTION

### 3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Provide all materials and equipment for the Work. Furnish and install necessary apparatus, parts, materials, and accessories.

#### B. Pipe Installation:

1. Install piping parallel to wall and provide an orderly grouping of proper materials and execution.
2. Piping shall clear obstructions, preserve headroom, provide openings and passageways clear, whether indicated or not. Verify the Work of other Divisions to avoid interference.
3. If obstructions or the Work of other Divisions prevent installation of piping or equipment as indicated by the Drawings, perform minor deviations as required by the Architect.
4. Install piping after excavation or cutting has been performed. Piping shall not be permanently enclosed, furred in, or covered before required inspection and testing is performed.
5. Exposed polished or enameled connections from fixtures or equipment shall be installed with no resulting tool marks or threads at fittings. Residue or exposed pipe compound shall be removed from exterior of pipe.
6. Piping shall be concealed in chases, partitions, walls, and between floors, unless otherwise directed or specifically noted on Drawings. When penetrating wood studs, joists, and other wood members, provide such members with reinforcement steel straps of Continental Steel & Tube Co., ULINE, Independent Metal Strap, or equal.
7. Reduce fitting where any change in pipe size occurs. Bushings shall not be furnished unless specifically reviewed by the Architect, or indicated on Drawings.

8. Piping subject to expansion or contraction shall be anchored in a manner, which permits strains to be evenly distributed. Swing joints or expansion loops shall be installed. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping. Seismic loops required at all building separations.
9. Immediately after lines have been installed, openings shall be capped or plugged to prevent entrance of foreign materials. Caps shall be left in place until removal is necessary for completion of installation.
10. Couplings shall not be installed except where required pipe runs between other fittings are longer than standard length of type of pipe being installed and except where their installation is specifically reviewed by the Architect.
11. Water piping shall be installed generally level, free of traps, unnecessary offset, arranged to conform to building requirements, clear of ducts, flues, conduits, and other Work. Piping shall be arranged with valves installed to provide for complete drainage and control of system. Piping shall not be installed which causes an objectionable noise from flow of water therein under normal conditions. Refer to Section 23 0500: Common Work Results for Plumbing.
12. Water lines may be installed in same trench with sewer lines, provided bottom of water line is 12 inches minimum above top and to the side of sewer line.
13. Changes in pipe sizes shall be furnished with eccentric reducers, flat on top. Offsets to clear obstruction shall not be installed so as to produce air pockets.

C. Pipe Sleeves and Plates:

1. Provide pipe sleeves of Schedule 40 black steel pipe or Schedule 40 PVC plastic pipe in concrete or masonry walls, footings, and concrete floors below grade. Provide adjustable submerged deck type sleeves at locations where pipes pass through concrete floors, except concrete slab floors on grade, and at locations where soil pipe for floor type water closets passes through concrete floors.
2. Sleeves shall provide  $\frac{1}{2}$  inch clearance around pipes, except plastic pipe shall have 1 inch clearance. Caps of deck type sleeves shall be removed just prior to installation of pipe. Area around sleeves shall be smooth and without high or low spots. Sleeves in walls shall not extend beyond exposed surface of wall. Sleeves in concrete floors and walls shall be securely fastened to forms to prevent movement while concrete is being placed.
3. Piping installed on a roof shall clear the roof surface by 10 inches minimum, with or without insulation. Bottom of individual fittings may infringe on 10 inches clear space but not groups of fittings or fittings located within 27 inches of each other.

4. Stiles shall be provided to facilitate crossing of piping when parallel piping runs are laterally greater than 12 inches out-to-out, or any pipe is higher than 18 inches, and more than 40 feet long or runs between two or more major pieces of equipment or housings greater than 20 feet apart. Stiles shall be not less than 20 inches wide with a minimum tread depth of 10 inches. Where stiles are required, they shall be located so greatest obstructed distance is 30 feet.
  5. Where pipes pass through waterproofed walls, floors, or floors on grade, sealant with Link-Seal Modular Seals, or equal, between pipe and sleeve to provide a waterproof joint. Where earth is in contact with pipe on both sides of a wall or foundation, the waterproof joint is not required. Commercial rubber compression units may be furnished instead of sealed sleeves if reviewed by the Architect.
  6. A swing joint, or other required device, shall be furnished and installed in hot water lines with 10 feet of sealant or compression joint to allow for expansion.
  7. Provide polished, chrome-plated flanges when plumbing pipes pass through walls at plumbing fixtures, etcetera as specified in Section 22 4000 Plumbing. Provide polished steel, chromium-plated split floor and ceiling plates at locations where pipes pass through walls, floors, ceilings, and partitions in finished portion that neatly conceals pipe insert.
  8. Pipe sleeves shall be provided where pipes intersect footings or foundation walls and sleeve clearances shall provide for footing settlement, but not less than one inch all around pipe.
- D. NOT USED
- E. NOT USED
- F. NOT USED
- G. NOT USED
- H. NOT USED
- J. Pipe Joints and Connections:

1. Pipe and tubing shall be cut per IAPMO Installation Standards. Pipe shall have rough edges or burrs removed so that a smooth and unobstructed flow shall be provided.
2. Hot tapping of gas lines is strictly prohibited.
2. Threaded Pipe: Joints in piping shall be installed according to the following service schedule:

- a. Soap Piping: Litharge and glycerine, or Expando, Gasoila, or equal.
  - b. Plastic Piping: Teflon pipe joint compound tape.
  - c. Oxygen Piping: Wash treads with S.P., rinse, blow-dry and apply litharge and glycerine.
  - d. Cleanout Plugs: No compound shall be used. After inspection and test, plugs shall be removed, cleaned, greased, and replaced.
  - b. Other services furnish sealant, suitable and as reviewed by the Architect.
3. Threads on pipe shall be cut with sharp, clean, unblemished dies and shall conform to ANSI/ASME B2.1 for tapered pipe threads.
4. Joint compounds shall be smoothly placed on male thread and not in fittings. Threaded joints shall be installed tight with tongs or wrenches and sealant of any kind is not permitted. Failed joints shall be replaced with new materials. Installation of thread cement or sealant to repair a leaking joint is not permitted.
5. Sharp-toothed Stillson, or similar wrenches, is not permitted for the installation of brass pipe or other piping with similar finished surfaces.

K. Copper Tubing and Brass Pipe with Threadless Fittings:

- 1. Silver brazed joints shall be used for attaching fittings to non-ferrous metallic refrigerant piping.
- 2. Non-pressure gravity fed condensate lines may be soldered with 95/5 solder.
- 3. Silver brazing alloy, Class BCUP-5. Surfaces to be joined shall be free of oil, grease, and oxides. Socket of fitting and end of pipe shall be thoroughly cleaned with emery cloth and wiped to remove oxides. After cleaning and before assembly or heating, flux shall be installed to each joint surface and spread evenly. Heat shall be applied in accordance with instructions in the Copper Tube Handbook issued by Copper Development Associates. Joints constructed of rough bronze fittings shall be provided as recommended by manufacturer.
- 4. Do not overheat piping and fittings when installing silver brazing.
- 5. Joints in non-ferrous piping for services not covered above shall be installed with solder composed of 95/5 tin/antimony, ASTM B32, Grade 5A. Surfaces to be jointed shall be free of oil, grease, and oxides. Sockets of fitting and end of pipe shall be cleaned with emery cloth to remove oxides. Solder flux shall be sparingly installed and solder added until joint is completely filled. Do not overheat. Excess solder, while plastic, shall be removed with a small brush in order to provide an uninterrupted fillet completely around joint. Random

inspection of joints shall be conducted by Project Inspector to ensure joints are lead-free.

6. Grooved end joints for copper piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.
- L. Ring-Type Pipe: Joints shall be installed in accordance with manufacturer's instructions with grooved couplings, fittings and rubber rings. Couplings and pipe shall be compatible and of the same manufacturer. Rings shall be accurately located and installed by grooves in coupling. Pipe shall be installed with zero deflection unless otherwise specified. Pressure pipe shall be furnished with thrust blocks at each offset point.
- M. Welded Pipe Joints:
  1. Joints in welded steel pipelines shall be installed by oxyacetylene or electric arc process. Welding shall be continuous around pipe and provided as specified.
  2. Butt welds shall be of the single V-type, with ends of pipe and fittings beveled approximately 37 ½ degrees. Piping shall be aligned before welding is started with the alignment maintained during welding.
  3. Welds for flanges and socket fittings shall be of the fillet type with a throat dimension not less than pipe wall thickness.
- N. Grooved End Pipe Joints: Grooved end joints for carbon steel piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.
- O. Joints shall be Vic-Press 304TM, or equal, made with Victaulic Series 'PFT' tools and the appropriate sized jaw. Pipe shall be certified for use with Vic-Press 304TM system, and shall be square cut, properly deburred and cleaned, and marked at the required location to insure full insertion into the fittings and/or couplings.
- P. Polyethylene (Plastic) Pipe:
  1. Joints shall be installed by the heat fusion method, in accordance with manufacturer's recommendations and IAPMO installation standard IS 12, for natural gas.
  2. Pipe Riser at Meter, Regulator and Building Wall: Prefabricated, anodeless type, utilizing a grade level transition between underground polyethylene pipe

and gas supply steel pipe of riser outlet, R. W. Lyall Co., or equal. Below grade to above grade transition shall be installed in a welded, epoxy coated, steel casing.

3. Connections to Existing Pipe Line or Branch:

- a. Steel-to-plastic (PE): Provide manufacturer's prefabricated standard transition fitting, transition from epoxy-coated steel pipe to plastic, R. W. Lyall Co., or equal.
  - b. Plastic-to-plastic, PVC to PE: Provide manufacturer's prefabricated standard transition fitting, transition from PVC to epoxy-coated steel pipe to PE; R.W. Lyall Co., or equal..
  - c. Plastic-to-plastic, PE to PE: Provide manufacturer's standard fused tapping tee assembly with shut-off feature.
4. Provide PE reinforcing sleeves where PE pipe is fused to multi-saddles, service punch tee, reducing tees, transition fittings and anodeless risers.

Q. Valves: Valves shall conform to the following:

1. Piping systems shall be furnished with valves at points indicated on Drawings and specified, arranged to provide complete regulating control of piping system throughout building and the Project site.
2. Valves shall be installed in a neat grouping, so that parts are easily accessible and maintained.
3. Valves shall be full size of line in which they are installed, unless otherwise indicated on Drawings or otherwise specified, and shall be one of types specified.
4. Provide chain operators on valves 2-inch and larger located 7 feet or more above the servicing floor level.
5. Valves for similar service shall be of one manufacturer.
6. Except where otherwise specified, valves shall be Belimo, Victaulic, Stockham, Crane, Jenkins, Milwaukee, Hammond, American, NIBCO, Hoffman, or equal.
7. Ball valves below grade in yard boxes shall have stainless steel handles.
8. Hose bibs in dense garden areas shall be  $\frac{3}{4}$  inch in size with one hose bib in the lunch pavilion 1 inch in size. Other hose bibs shall be  $\frac{3}{4}$  inch lock shield type. Bibs shall be furnished with vacuum breaker protection.

9. Safety valves and pressure relief valves shall have stamp of approval as required by ASME and shall be provided with annual test lever. Where a hot water storage tank is heated by means of a coil, pressure relief valve shall have a steam BTU discharge rating of the coil. Discharge pipe from safety or pressure relief valves shall be not less than one pipe size larger than inlet pipe size of valve. Discharge pipe shall terminate as indicated and shall be free of traps. In addition to locations specified, pressure relief valves shall be installed in the following locations:
    - a. On discharge side of each pressure-reducing valve.
    - b. On each water heater connected to a hot water storage tank and other pressure vessels.
    - c. On cold water line to each water heater or hot water storage tank when there is a check valve, backflow prevention valve or similar device between water heater or hot water storage tank and meter or relief valve at the pressure reducing valve assembly.
    - d. On discharge side of each air compressor.
    - e. On each air receiver connected to an air compressor.
  10. Temperature relief valves and combination temperature and pressure relief valves shall be as specified and furnished as set forth in this Section. Discharge pipe from relief valves shall be not less than discharge area of valve or valves it connects, based on discharge area of valves, and shall terminate as indicated and free of any traps. Valves shall be installed at following locations:
  11. A combination temperature and pressure relief valve or combination of valves on each heating hot water storage tank. Temperature sending element shall extend into water inside tank.
  12. Manual air vent valve assemblies shall be installed at each high point of hot water space heating and chilled water piping systems. Valves shall discharge through 1/4 inch diameter copper tubing and drain to nearest floor sink. Automatic type air vent valve shall only be installed where specifically indicated. Radiator, convectors, and finned pipe convectors shall be fitted with packless radiator valves, angle or straight pattern. Each convector or radiator installed as part of a space hot water heating system shall be furnished with a manual-type air vent valve.
- R. Strainers: Strainers shall be installed on each water main (except for fire line) downstream of the meter, above grade, when a pressure regulator assembly is not installed. Main strainer shall be of Y-flange or groove type. On closed loop chilled and heating hot water systems pump systems, a strainer shall be installed at each pump inlet and upstream of each flow control valve assembly. The control valve assembly may

include a modulating temperature control valve and a flow-limiting valve, manufactured by Griswold, AutoFlow, Flow Control Industries, Inc., or equal.

S. Hangers and Supports:

1. Piping shall be securely fastened to building structure by approved iron hangers, supports, guides, anchors, and sway braces to maintain pipe alignment to prevent sagging and to prevent noise or excessive strain on piping due to uncontrolled or seismic movement under operating conditions. Hangers and supports shall conform to Manufacturer's Standardization Society Specification SP-69. Hangers shall be relocated as required to correct unsatisfactory conditions that may become evident when system is placed into operation. Appliances, heat exchangers, storage tanks, and similar equipment shall be securely fastened to structure in accordance with seismic requirements. Outdoor metal hangers and supports shall be hot-dipped galvanized steel, unless otherwise specified.
2. Hose faucets, compressed air outlets, and similar items at ends of pipe branches shall be rigidly fastened to building construction near point of connection.
3. Piping shall not be supported by wire, rope, wood, plumbers' tape, or other non-recognized devices.
4. Hangers and supports shall be designed to support weight of pipe, fittings, weight of fluid and weight of pipe insulation, and shall have a minimum factor of safety of five, based on ultimate tensile strength of material installed.
5. Burning or welding of any structural member under load is not permitted. Field welding not specified on Drawings or reviewed Shop Drawings is not permitted without review by Architect and DSA.
6. Burning holes in beam flanges or other structural members is not permitted without review by the Architect and DSA.
7. Pipe hangers on piping covered with low temperature insulation shall be installed on outside of insulation and not in contact with pipe unless otherwise detailed on Drawings. Insulation shall be protected by 18 gage galvanized steel shield, with a minimum length of 10 inches, installed completely around pipe covering between covering and hanger. Installing hangers directly on pipe and butting adjoining sections of insulation against hanger is permitted provided void and hanger rod are properly insulated and sealed so that no sweating occurs at hangers.
8. Hanger rods shall be fastened to structural steel members with suitable beam clamps. Clamps shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:

- a. Tolco I beam, Fig. 62 for maximum 1000 pounds.
  - b. Tolco I or WF beam, Fig. 329, for maximum of 1290 pounds.
9. Hanger rods shall be fastened to concrete inserts in concrete slabs or beams. Inserts shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
- a. Tolco Fig. 310 for maximum of 600 pounds.
  - b. Tolco Fig. 309 for maximum of 1140 pounds.
10. For fastening to wood ceilings, beams, or joists, furnish Grinnell Fig. 128R, Grinnell Fig. 153, Tolco 78, or equal pipe hanger flange fastened with drive screws. Under wood floors, 3/8 inch hanger rods shall be hung from 2-inch by 2-inch by 1/4 inch angle clips 3 inches long, with 2, staggered 10d nails, clinched over joist.
11. Hanger rod sizes for copper, iron, or steel pipe: 3/8 inch for pipe sizes 1/2 inch through 2-inch, 1/2 inch for pipe sizes 3-inch, 4-inch and 5-inch, 5/8 inch for pipe size 6-inch, and 3/4 inch for 8-inch and 10-inch pipe.
12. Turnbuckles, if furnished, shall provide a load carrying capacity equal to that of the pipe hanger with which they are being installed.
13. Pipe hangers shall be of same size, or nearest larger manufactured size available, as pipe or tubing on which they are being installed.
14. Hangers, clamps, and guides furnished for support of non-metallic pipe shall be padded with 1/8 inch thick rubber, neoprene, or soft resilient cloth.
15. Where special pipe-supporting requirements in the Specifications conflict with any standard requirements specified herein, the Specification requirements shall govern.
16. Vertical Piping:
  - a. Vertical pipe risers shall be securely supported with riser clamps of recognized type. Risers in reinforced concrete buildings shall be furnished with extension clamps fastened to pipe above each concrete floor slab with extended arms of clamp to rest on slab. Clamps shall be provided with lead or Teflon liners when installed on copper tubing. Clamps shall be plastic-coated when installed on non-ferrous pipe or tubing.

- b. Copper tubing in sizes 1 ½-inches and larger and steel pipelines passing up through building shall be supported at each floor of building or every 15 feet whichever is less.
- c. Copper tubing sizes 1 ¼-inches and smaller shall be supported at not intervals not more than 6 feet on center. Special provisions shall be installed for vertical lines subject to expansion and contraction caused by operating temperature differences.
- d. Vertical cast iron pipelines shall be supported from each floor and at its base. Malleable iron or steel pipe clamps with minimum thickness of 1/4 inch shall be furnished and fastened around pipe for support.

17. Horizontal Piping:

- a. Roof Mounted Piping: Pressure and non-pressure piping shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Block, or equal. Roller type supports shall be provided below and above pipe to prevent its dislodgement. Bottom of pipes shall clear the roof surface by 10 inches.
- b. Insulated steam and space heating hot water insulated condensate lines, insulated domestic hot water supply and return piping shall be supported with Tolco Figure 4, B-Line Figure B3140, Grinnell Figure 212, or equal, steel hangers with welded eye rods to permit hinge movement at point of attachment of hangers. Hinge movement at point of support shall be provided by welded eye linked rods Tolco Figure 101L, B-Line Figure B3211X, Grinnell Figure 278, or equal.
- c. Domestic cold water piping, water supply and return piping, condenser water piping, insulated refrigerant piping gas piping, compressed air piping, cast iron soil piping, galvanized steel vents, waste and downspout piping and glass to be supported with Tolco Figure 1, B-Line Figure B3100, Grinnell Figure 260, or equal, hangers with rods, turnbuckles and inserts suitable for above hangers.
- d. Maximum hanger and support spacing shall conform to CPC schedule for horizontal piping installed above grade.

18. A hanger or support shall be installed close to the point of change in direction of a pipe run, in either a horizontal or vertical plane.
19. When practicable, supports and hangers for cast iron soil pipe shall be installed as close as possible to joints and when hangers or supports are not located within one foot of a branch line fitting, an additional hanger or support shall be installed at fitting.

20. In systems where grooved piping is used, couplings shall be provided with angle pattern bolt pads to comply with support and hanging requirements of ANSI/ASME B31.1, ANSI/ASME B31.9, and NFPA Pamphlet 13.

T. Flashings:

1. Each pipe, duct, or gas-fired equipment vent passing through roof shall be installed with waterproof flashing.
2. Flashing or flanges on pipes, vents, and ducts passing through a tile or slate roof shall be constructed of sheet lead. Flashing for pipes and heater vents passing through a roof shall be 4 pound soft sheet lead. Flashing and flanges for ducts and heater vents passing through exterior walls shall be 22 gage sheet metal. Flanges and flashing shall be installed waterproof at point of connection with pipe or duct. No soldered joints on roof flashings will be allowed.
3. Lead flashing and flanges shall be constructed of 4 pound sheet lead with burned joints. Flange of lead flashing or lead flange on a duct shall extend out onto roof a minimum of 12 inches from pipe or duct. Lead flashing shall extend up the pipe or duct not less than 7 inches.
4. Sheet metal flashing shall be constructed of 24 gage galvanized sheet steel. Flanges on these flashings shall extend out onto roof a minimum of 10 inches from pipe or duct. Flanges on ducts through exterior walls shall extend out from duct a minimum of 2  $\frac{1}{2}$  inches. Flanges on gas-fired equipment single-wall vents shall be of ventilated type. Type B gas vents through a roof shall be furnished with non-ventilated flashing as per NFPA Pamphlet 211.
5. Cast iron, steel, brass, and copper pipe, which terminates less than 18 inches above roof, shall be furnished with a combination counter-flashing and vandal-proof hood for protection against water, birds and foreign matter. Cast iron, steel, brass and copper pipe, which does not terminate within 18 inches of roof, shall be furnished with a counter-flashing sleeve. Pipe, which terminates more than 18 inches above roof, shall be furnished with protection against entrance of water, birds, and foreign matter.
6. Counter-flashing and combination counter-flashing sleeves and vandal-proof hoods shall be cast iron, vandal-proof, threaded, sealed or approved gas-heated sleeve type. Counter-flashing sleeves on each of these items shall extend down over flashing a minimum of  $\frac{3}{4}$  inch.
7. Flashing and flanges on ducts shall be installed waterproof at point of connection to the duct by riveting and soldering. Storm collars shall be securely screwed and installed waterproof around appliance vent pipe immediately above flashing.

8. Vent piping above roof shall be furnished with a combination counter-flashing sleeve and vandal-proof hood.
- U. Equipment Installation: Install roof or floor mounted equipment on level platforms, housekeeping pads or curbs and provide sound, vibration and seismic control measures per Section 23 0548 even if not indicated on Drawings.

END OF SECTION

**SECTION 22 0553**  
**PLUMBING IDENTIFICATION**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Marking and identification on mechanical piping systems, ducts, controls, valves, and apparatus.
- B. Related Requirements:
  - 1. Division 01: General Requirements
  - 2. Section 22 0513: Basic Plumbing Materials and Methods.
  - 3. Section 22 1000: Plumbing.
  - 4. ~~Section 22 2013: Plumbing Piping~~

**1.02 SUBMITTALS**

- A. Submit in accordance with Division 01 and Section 22 0500: Common Work Results for Plumbing.
- B. Submit product data and installation instructions for each item specified.
- C. Submit Samples of materials.

**1.03 QUALITY ASSURANCE**

- A. Comply with provisions of:
  - 1. Section 22 0500: Common Work Results for Plumbing.
  - 2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.
  - 3. APWA: Uniform Color Code.
  - 4. IAPMO: Uniform Plumbing Code (UPC)

**PART 2 – PRODUCTS**

**2.01 MATERIALS**

- A. General: Piping systems, controls, valves, apparatus, etc., except those that are installed in inaccessible locations in partitions, walls, and floors, shall be permanently identified.

**2.02        VALVES**

- A. Furnish prepared chart or diagram for each piping system, indicating by identifying letter or model number of each valve in the system, its location, and function.
- B. Install charts in aluminum frame with clear glass front and secure on wall where designated by the Project Inspector.
- C. Bind copies of each chart in operating instructions manual.
- D. Provide each valve with a brass, aluminum, or plastic disc, not less than 1-1/4 inches diameter bearing engraved numbers corresponding to those indicated on chart. Fasten discs to valve with No. 14 brass wire.
- E. Provide an additional tag for safety valves and other valves that could be hazardous to safety and health of occupants. Distinguish these tags from regular valve tags by color (such as yellow with black letters, and marked "Danger"); submit Sample tag to the Architect for review.

**2.03        INSTRUMENTS AND CONTROLS**

- A. Identify panel-mounted instruments and controls with engraved bakelite nameplates permanently affixed to panel boards.
- B. Identify alarm indicating devices and alarm reset devices by nameplates.
- C. Identify automatic valves, flow switches, and pressure switches, with embossed aluminum or plastic tape affixed to controller, indicating service and setting.

**2.04        EQUIPMENT**

- A. Identify each major piece of equipment with engraved bakelite nameplates permanently affixed to the equipment, indicating the room numbers it services. Equipment identification designation shall be the same to its designation indicated on the "As-Built Drawings". Room numbers in the nameplates shall correspond to the final room numbers.

**2.05        ABOVE GRADE PIPE IDENTIFICATION**

- A. Identify pipes by means of colored labels with directional flow arrows and identification of the pipe content, in conformance to ANSI/ASME A13.1 or the UPC.
- B. Materials: Precoiled acrylic plastic with clear polyester coating, all-temperature, self-adhering, as manufactured by Brady, Brimar Industries, Seton, Stranco, Inc., or equal.

## C. Size:

<b>Outside Diameter of Pipe or Insulation (in inches)</b>	<b>Length of Color Field (in inches)</b>	<b>Size of Letter (in inches)</b>
¾ to 1 ¼	8	½
1 ½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
over 10	32	3 ½

## D. Locations:

1. On accessible piping, whether insulated or not (including mechanical rooms, attic and ceiling spaces); except that labels shall be omitted from piping where contained material is obvious due to its connection to fixtures (such as faucets, water closets, etcetera.).
2. Near each valve and branch connection in such accessible piping.
3. At each pipe passage through wall or floor.
4. At not more than 20 feet spacing on straight pipe run between bands required in 2 and 3 above.
5. At each change in direction.

E. Application: Install on clean surfaces free of dust, grease, oil, or any material that will prevent proper adhesion. Replace non-adhering or curling labels with new labels.

## F. Color Schedule:

<b>Content of Pipe</b>	<b>Legend</b>	<b>Background Color</b>	<b>Lettering Color</b>
Domestic cold water	Domestic C.W.	Green	White
Non-potable cold water	Caution: Non-potable Water Do Not Drink (1)(2)	Purple	Black
Domestic hot-water 140°F	Domestic H.W. 140°F	Blue	Black
Sanitary waste	San waste	Green	White

Sanitary vent	San vent	Green	White
Storm drain or downspout	Storm drain	Green	White
Indirect drain	Ind drain	Green	White
Sump pump discharge	Pump discharge	Green	White
Fire sprinkler supply	Fire Sprinkler supply	Red	White
Fire sprinkler drain	Sprinkler drain	Red	White
Fuel oil	Diesel oil	Yellow	Black
Gas	Gas	Yellow	White
Reclaimed Water	Caution: Reclaimed Water Do Not Drink (1)(3)	Purple	Black

H. Notes on Schedule:

1. Note (1) indicates 2 ¼ inch by 1 inch yellow label with ½ inch letters reading UNSAFE WATER at one end of primary label.

Note (2) words should read “CAUTION: NONPOTABLE WATER DO NOT DRINK.” with international *do not drink* symbol.

Note (3) words should read “CAUTION: RECLAIMED WATER DO NOT DRINK.” with international *do not drink* symbol.

2.06 UNDERGROUND PIPE

A. Detectable Marking Tape:

1. Provide and install detectable marking tape along buried piping. Tape shall be specifically manufactured for marking and locating underground utilities with electronic equipment. Tape shall be acid and alkali resistant, and manufactured with integral wires or foil backing, encased with protective cladding. Tape shall be a minimum of two inches in width.
2. Manufacturer: Reef Industries, Inc., Advantage Brands, Inc., Northtown Company, Mutual Industries, Inc., or equal.
3. Detectable marking tape shall be color-coded per APWA Color Code:
  - a. Yellow: Oil and gas.
  - b. Blue: Water, irrigation and slurry lines.
  - c. Green: Sewer and drain lines.

B. Tracer Wire:

1. Solid copper wire type THWN, 12 AWG gauge, with heat and moisture resistant insulation.

**PART 3 – EXECUTION**

**3.01 INSTALLATION**

- A. Correct detrimental conditions prior to commencing the Work of this Section. Install markers and identification tags as specified with materials and installation procedures recommended by manufacturer.
- B. Place tracer wire on top of non-metal utility lines allowing some slack. Do not wrap tracer wire around pipe. Fasten tracer wire in place at approximately 10 feet on centers with non-metal ties.
- C. Install underground detectable pipe marking tape continuously buried 8 to 10 inches above the buried utility pipe. Wrap tape on pipe risers up to a height of 12 inches above grade.

**3.02 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION**

## SECTION 22 1000

## PLUMBING

## PART 1 - GENERAL

## 1.01 SUMMARY

- A. Section Includes: Labor, materials, tools, and equipment to install plumbing systems as indicated.
- B. Related Sections:
  - 1. Division 01 - General Requirements.
  - 2. Section 07 9200: Joint Sealants.
  - 3. Section 22 0513: Basic Plumbing Materials and Methods.
  - 4. Section 22 0553: Identification for Plumbing piping and Equipment.
  - 5. Section 31 2323: Excavation, Backfill for Utilities.

## 1.02 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 22 0500: Common Work Results for Plumbing.
- B. Provide necessary documentation to Owner for processing rebates for water efficient fixtures.

## 1.03 QUALITY ASSURANCE

- A. Unless otherwise noted, the California Plumbing Code is hereby made part of this section.
- B. Conform to provisions of Section 22 0500: Common Work Results for Plumbing.
- C. Manufacturer of plumbing products must have ANSI/NSF Standard 61, Section 9 certification to demonstrate compliance with the federal requirements for lead contribution to drinking water, Safe Drinking Water Act SDWA and AB 1953.

## 1.04 PRODUCT HANDLING

- A. Conform to provisions of Section 22 0513: Basic Plumbing Materials and Methods.

## PART 2 - PRODUCTS

### 2.01 PIPING SYSTEMS

- A. Materials: Refer to Section 22 0513: Basic Mechanical Materials and Methods.
- B. Insulation for Piping: Refer to Section 23 0700: Plumbing Insulation.

### 2.02 FIXTURES AND DRAINS

- A. General: Fixtures specified shall be furnished complete with trim and fittings. Cast iron plumbing fixtures shall be acid resistant enamel, and identified by casting letters "AR" or words "acid-resistant" into metal. Fixtures shall be white unless otherwise specified. Cast iron fixtures shall be white enamel inside and on back, rim and apron, with exposed unfinished surfaces painted white. Fixtures of same general classifications shall be of same make.
- B. Finished Brass:
  - 1. Unless otherwise specified, finished brass of a similar type shall be of same manufacturer and model throughout buildings.
  - 2. Finished and exposed brass equipment, except floor, shower and urinal drains shall be chromium-plated and polished. Floor, shower and urinal drains, unless otherwise specified, shall be nickel-bronze metal.
- C. Traps, Trap Arms and Tailpieces:
  - 1. Fixture traps shall be all cast brass, chromium-plated and polished. Exceptions as follows:
    - a. Traps that are an integral part of a fixture.
    - b. Traps concealed in floors, walls and furring.
    - c. Traps standard for service sinks and Industrial Shop equipment.
    - d. Laboratory traps and tailpieces shall be as specified in section 22-0700.  
“Basic Plumbing Materials and Methods”
  - 2. Concealed traps and 17 gage tailpieces may be rough brass finish, except as otherwise specified. Laboratory traps and tailpieces shall be as specified in Section 22 0700: Basic Plumbing Materials and Methods. Furnish chromium-plated and polished cast brass wall flanges with setscrews and chromium-plated and polished brass casing on discharge side of each trap.

- 3. Tailpieces shall be not lighter than 17 gage, brass, chromium-plated, and polished. Furnish and install chromium brass plated wall flanges with set screws and chromium-plated 20 gage brass casing on discharge side of each chrome-plated all cast trap.
- D. Faucet and Shower Valve Handles: Faucet and shower valve handles shall be solid brass, chromium-plated and polished, and fastened to their stems by Allen type hollow head stainless steel set screws through the side of the handle extending into the stem. Handles with sharp edges or projections shall not be furnished.
- E. Fixture Supplies:
  - 1. Supplies for water heaters shall be unplated rigid copper water tube with threaded adaptors for connections to valves and other threaded connections. All other supplies shall be chromium-plated brass with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
  - 2. Exposed supplies for showers shall be chromium-plated brass pipe up to header with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
  - 3. Supplies to water closet tanks, lavatories, and drinking fountains shall be furnished with chromium-plated and polished screwed type angle compression stops with square shank stems and lock shields extending beyond stem. Instead of solid supply piping, polished chrome-plated risers of 3/8 inch outside diameter with ferrule stop end and metal nosepiece may be furnished. The installation of braided stainless or easy hooker's supplies is not permitted. Exception: Supplies that rise vertically from floor shall be furnished with straight type instead of angle type stops.
  - 4. Each supply or pipe that penetrates a finished surface and plumbing pipes passing through a countertop or part of a cabinet shall be furnished with a chromium-plated brass flange except flanges furnished by manufacturer of flush valves as an assembly.
  - 5. Water supplies of plumbing fixtures shall be protected against back-siphonage in event of a vacuum in piping system.
  - 6. Discharge outlets of supply faucets for lavatories and sinks shall clear top of overflow rim by at least one inch.
  - 7. Toilet and urinal flush valves shall be furnished with recognized atmospheric vacuum breakers, installed a minimum of 6 inches above fixture.

## 2.03 ACCESS PLATES

- A. Schedule Numbers:

AP-3: Square, polished face chrome-plated bronze, aluminum alloy or brass chrome-plated brass frame with 14 gage polished 18-8 No. 302 stainless steel or brass chrome-plated secured cover with vandal-proof screws.

SMITH	ZURN	WADE	WATTS	MIFAB	JOSAM	OR EQUAL
4735U	Z-1460-VP	58630	CO-300-S-6	C1400-S-3-6	58640-VP	

## 2.04 BACKFLOW PREVENTION ASSEMBLIES

### A. Schedule Numbers:

BPV-2: Non-pressure type, atmospheric vacuum breaker, Los Angeles City approved.

CHAMPION	WATTS	WILKINS	OR EQUAL
262	288A	35	

## 2.05 BACKWATER SEWER VALVE ASSEMBLY

### A. Schedule Numbers:

BSV-1: Cast iron with access cover, Los Angeles City approved type, with line size gate valve upstream and downstream.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
7022-S	Z-1090	BV-200	BV-1000	67500	

## 2.06 CLEANOUT ASSEMBLIES

### A. Cleanout plug shall be line size.

### B. Schedule Numbers:

CO-3: Secured cover, extra heavy-duty, adjustable sleeve, cut-off ferule, UPC. Brass approved type plug, scoriated tractor type cover.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
4233-U	ZN-1400-HD	CO-200-RX-4	C1220-4-6	55000-22	

CO-5: Raised threaded head brass plug.

ZURN	WAATS	SMITH	JOSAM	OR EQUAL
Z-1470-A	CO-590	4285	58540-20	

2.07 NOT USED

#### 2.08 DRINKING FOUNTAINS

- A. Also see Electric Water Coolers, below.
- B. Drinking Fountains shall be provided with brass free waterways and lead mitigating water filtering systems (DFWF).
- C. Schedule Numbers:  
DF-8A: Access compliant dual height white porcelain enamel cast iron wall-mounted drinking fountains; furnish with brass free vandal-resistant bubbler heads, cast brass waste strainers, stream adjustable push button operation pressure regulating valves. Bottom cover plates, low profile 1-1/4 inch cast brass trap, stainless steel screen water supply strainer. Access compliant and certified lead free to ANSI/NSF Standard 61, Annex G. Furnish a 3/16 inch thick steel mounting plate number 6715, which can also be installed with model No. 6800 concealed carrier steel struts for additional support where wall-mounted fountain may be subjected to excessive leverage. **(To be specified for indoor or outdoor use.)**

HAWS	ACORN AQUA	OR EQUAL
1501 Mounting Plate # 6715	A152J00S	

2.09 DRUM TRAPS

- A. Schedule Numbers:

DT-1: Extra heavy cast iron, bolted top.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
8714	ZA1180	SI-742-X	MI-SOLID-S-	61030	

DT-2: Aluminum solid interceptor, furnish for on-floor installation.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
8710-AA	Z-1180	SI-742	MI-SOLID-S-AL	61030-26	

## 2.10 DIELECTRIC UNIONS

## A. Schedule Numbers:

1. Dielectric style Unions using ferrous and no-ferrous metals are prohibited.  
Dielectric flanges are admitted for use – see DU-2.

DU-1: Brass union with 6-inch brass nipple.

DU-2: Brass union or Brass flanged fittings are to be used in between pipes made of dissimilar metals to prevent accelerated corrosion and deterioration in the piping systems due to galvanic and stray current.

WATTS	WILKINS	ZURN	OR EQUAL
3100-CXC,	DUX SERRIES	DUXL	

2.11 NOT USED

2.12 NOT USED

2.13 NOT USED

2.14 NOT USED

2.15 NOT USED

2.16 NOT USED

2.17 NOT USED

2.18 NOT USED

2.19 NOT USED

2.20 NOT USED

2.21 NOT USED

2.22 NOT USED

2.23 PIPE HANGERS

A. Refer to Section 22 0513: Basic Plumbing Materials and Methods.

## B. Schedule Numbers:

1. PH-1: Complete with clamps, inserts, etcetera.

SUPERSTRUT	UNISTRUT	TOLCO	B-LINE	OR EQUAL

2.24 P-TRAPS

## A. Schedule Numbers:

PT-1: Cast brass complete, chrome-plated.

ZURN	AB&A	KOHLER	OR EQUAL
Z-8712-LC	107	K-9018	

2.25 NOT USED

2.26 NOT USED

2.27 NOT USED

2.28 NOT USED

2.29 NOT USED

2.30 NOT USED

2.31 NOT USED

2.32 NOT USED

2.34 NOT USED

2.36 NOT USED

2.37 NOT USED

2.38 NOT USED

2.39 NOT USED

2.40 NOT USED

2.41 NOT USED

2.42 YARD BOXES

## A. Schedule Numbers:

YB-2: Same as YB-1, marked "WATER" (For use over water valves).

BROOKS 36- H MB with No. 36-T Cast iron Cover	EISEL 363.5	OR EQUAL
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YB-3: Same as YB-1, marked "SEWER"

BROOKS 36- H MB with No. 36-T Cast iron Cover	EISEL 363.5	OR EQUAL
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2.43 FIXTURE CONNECTIONS

## A. Branches to individual fixtures shall be of the following sizes unless larger sizes are indicated on Drawings:

	Copper, Cold	Copper, Hot	Trap and Connections	Soil/Waste	Vent
Fixture	Cold	Hot	Trap and Connections	Soil/Waste	Vent
WC Flush Valve	1 inch	-----	4-inch	4-inch	2-inch
Lavatories	½ inch	½ inch	1 ½-inch by 1 ¼-inch	2-inch	1 ½-inch
Sinks:					
Service	½ inch	½ inch	2-inch	2-inch	1 ½-inch
Kitchen	½ inch	½ inch	1 ½-inch by 1 ½-inch	2-inch	1 ½-inch
Classroom	3/8 inch	3/8 inch	1 ½-inch by 1 ½-inch	2-inch	1 ½-inch
Wash	¾ inch	½ inch	1 ½-inch by 1 ½-inch	2-inch	1 ½-inch
Drinking Fountains:					
Multiple	3/8 inch	-----	1 ½-inch by 1 ½-inch	2-inch	1 ½-inch
Single	3/8 inch	-----	1 ½-inch	2-inch	1 ½-inch
Individual Showers	½ inch	½ inch	2-inch	2-inch	2-inch
Fixture			Water Supply	Soil/Horizontal	Vent
Urinals, Wall-Hung Flush Valve					
Standard	¾ inch		2-inch	1 ½-inch	
Access Compliant Use	1 inch		2-inch	1 ½-inch	
Sill cocks	¾ inch minimum		-----	-----	

- B. Water headers serving water closets shall be copper water tube, with following size throughout length:
1. 1-1/2 inches for 2 flush valves.
  2. 2 inches for 3 to 9 flush valves.
- C. Water headers serving urinals shall be of following size throughout length:
1. 1" for 1 or 2 flush valves.
  2. 1-1/4" for 3 flush valves.
  3. 1-1/2" for 4 to 8 flush valves.
- D. Water headers serving showers shall be same as listed above for urinals.
- E. Water headers serving lavatories shall be of following size throughout length:
1. 1/2 inch for 2 lavatories.
  2. 3/4 inch for 3 and 4 lavatories.
  3. One inch for 5 and 6 lavatories.

## 2.44 HEIGHT OF FIXTURES

- A. Heights for standard fixtures.

Fixture	Adult and High School	Middle	Elem.	Kindergarten and Younger
Water Closets	15-inch	15-inch	15-inch	10-inch
Lavatories	32-inch	32-inch	30-inch	25-inch
Drinking Fountains	42-inch	40-inch	32-inch	30-inch
Wash Sinks	30-inch	30-inch	28-inch	24-inch
Urinals, lip height	24-inch	21-inch	18-inch	N/A
Shower Heads Male (Student and Instructor) From tip of shower head to finish floor.	72-inch	60-inch		
Shower Heads Female (Student and Instructor) From tip of shower head to finish floor.	72-inch	60-inch		
Shower valves	48-inch	48-inch		

- B. Heights for access compliant fixtures.

Fixture	Adult	Elementary	Kindergarten and Younger

Toilets, center line from wall	18-inch	15-inch	12-inch
Toilets, height to top of seat	17 to 19 inches	15-inch	10-inch-12-inch
Lavatories, sink top height	34-inch maximum	29-inch maximum	24-inch maximum
Lavatories, sink knee clearance	27-inch minimum	24-inch minimum	19-inch minimum
Urinals, lip height	17-inch maximum	15-inch maximum	N/A
Urinals, flush handle height	N/A	N/A	N/A
Drinking fountains, bubbler height.	36-inch maximum	32-inch maximum	30-inch maximum
Drinking fountains, knee clearance	27-inch minimum	24-inch minimum	22-inch minimum
Wash Sink	Per Drawings		
Shower Valves	Per CBC		
Shower Seat	Per CBC	Per CBC	Per CBC
Shower Head (adjustable) Bar	Per CBC		

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

A. General:

1. Unless otherwise specified, plumbing fixtures, equipment and appliances that require connections to plumbing line shall be connected. This shall include fixtures specified or indicated as furnished by others, furnished by Owner, or specified in other related sections. Install supplies, stops, valves, traps, wall flanges, or pipe casing for connection of this equipment.
2. Install equipment as indicated on reviewed and accepted Shop Drawings.
3. Avoid interference with Work of other trades. Do not deviate from Drawings without review of the Architect.

- B. Examination: Check each piece of equipment in system for defects verifying that parts are properly furnished and installed.
- C. For piping Work, refer to Section 22 0513: Basic Plumbing Materials and Methods.
- D. Plumbing Fixture and Equipment Installation:
  - 1. Unless otherwise indicated, fixtures shall be installed with 5/16 inch brass bolts or screws of sufficient length to securely fasten fixture to backing, wall, or closet ring.
  - 2. Fixtures installed against concrete or masonry walls shall have their hangers fastened with 5/16 inch brass bolts, Philip Shield type anchors, or 2 unit cinch anchors. Wood or plastic plugs are not permitted.
  - 3. Fixtures installed against wood or metal stud walls shall have their hangers fastened to metal backing plates with 5/16 inch brass bolts screwed into plate. Fixture hangers for urinals shall be fastened centered vertically on metal backing plate with three 5/16 brass bolts each for small individual hangers and six, for larger one piece hangers. Lavatories shall be hung with not less than four 5/16 inch brass bolts or not less than five 1/4 inch brass bolts. Each sink hanger shall be hung with not less than four 5/16 inch brass bolt or not less than five 1/4 inch brass bolts.
  - 4. Pan type drinking fountains shall be hung with 5/16 inch cadmium plated bolts with a bolt in each bolt opening in hanger. Hangers for pan type drinking fountains shall provide 2 inches (plus or minus 1/4 inch) between pan and wall. Spaces due to irregularities between fixtures and tile walls shall be neatly filled with white cement or silicone filler.
  - 5. Backing for hanging of plumbing fixtures and equipment shall be installed in supporting wall at time rough piping is installed. Backing for stud walls shall be steel plate 1/4 inch thick, not less than 4 inches wide. Backing for urinals shall be 1/4-inches thick by 6-inch wide steel plate. Steel plate shall be attached to stud at each end of plate and to each stud it crosses. Plate shall be attached to metal studs by bolting with two 1/4 inch U-bolts per stud with bolts through plate and around stud flange or by welding with a 1/8 inch fillet weld full width of stud flange, top and bottom of plate. At wood studs, plate shall be carefully recessed flush with face of stud and attached to each stud with 2 No. 14 flat-head wood screws, 2 inches in length into pre-drilled 1/8 inch holes. Backing for stud walls supporting wall-hung closets shall be as detailed.
  - 6. Rough-in for fixtures, equipment and appliances shall be as indicated on Drawings and as specified, including those items indicated as furnished by

others, furnished by Owner, or future capacity. When connections to equipment from capped or plugged lines are required, caps or plugs shall be removed at time equipment is set and stops or valves installed and connections provided as specified.

7. Piping materials for trap arms shall be Brass, Cast Iron or DWV copper
8. Piping shall be stubbed out to exact location of fixtures and stubs shall be installed symmetrical with fixtures. Hot and cold water supplies for center set faucets on lavatories shall be installed on 8-inch centers, unless otherwise specified or required.
9. Kitchen equipment requiring backflow protection with hot and cold water connections shall be installed with approved backflow prevention assemblies; BPV-3 and drain into floor sink with air gap.

E. Cleanouts in Drain, Waste, Vent and Sewer Lines:

1. Cleanouts shall be installed at locations stated in the California Plumbing Code and accessible at following locations:
  - a. At locations above first floor as stated on construction documents and 5 feet outside of the building.
  - b. Install an accessible main line upper terminal cleanout in all restrooms above water closet over flow. (Install above upper terminal water closet where there are more than one water closet in a restroom).
  - c. Above faucets of each sink with brass plug.
  - d. Above service sink with brass plug.
  - e. At each Drinking Fountain with brass plug.
  - f. At each urinal and locate above urinal with brass plug.
  - g. Above overflow level of pot sinks with brass plug.
  - h. In vertical line at base of each downspout connected to an underground storm drain system extend cleanout to exterior of building.
  - i. At upper end of a horizontal vent line when any part of horizontal line is below overflow level of fixture it serves.

- j. Not to exceed 100-foot intervals in sewer and waste lines exterior of building.
  - k. At property line connection.
  - l. Where indicated on Drawings.
2. Cleanouts shall be extended to grade as follows:
    - a. Not to exceed 100-foot intervals in straight runs of pipe outside buildings.
    - b. At horizontal changes of direction in aggregate greater than 135 degrees (underground).
    - c. At property lines.
    - d. Where cleanouts occur under concrete.
    - e. Where marked for future connections.
  3. Cleanouts in building shall be extended to floor level or above floor level or above floor level in walls or furring when cleanouts are not accessible or where clearance is less than 18 inches.
  4. Cleanouts in finished areas in building shall be concealed except that cleanouts above service sinks in janitor's rooms or closet, and cleanouts above service sinks or in exposed piping in boiler or heater equipment rooms, may be exposed. Cleanouts for urinals shall be installed above urinal and shall terminate behind an access plate.
  5. Cleanouts in floors of covered areas and those extended to grade in concrete areas shall be floor level type with extensions body brass plugs and detachable nickel-bronze or aluminum alloy scoriated.
  6. Concealed cleanouts in vertical lines shall be service weight soil cleanout tees with brass plugs and round cover plates unless otherwise specified or indicated. A snug fitting sleeve of galvanized sheet metal shall be placed around hub of tee and shall extend to flush with finished soil, or cleanout shall be extended to finished wall.
  7. Cleanouts extended from below floor to a wall or furring or on horizontal lines above floor that terminate at a wall or furring shall be iron body type with brass plugs and round cover plates.

8. Cover plates over cleanouts in painted walls shall be steel, bonderized and prime coated. Cover plates cover cleanouts in tile walls shall be chromium-plated brass or nickel bronze. Plates shall be attached to cleanout plugs with 5/16 inch No. 18 or 1/4 inch No. 20 stainless steel vandal-proof type screws. Plates shall be one inch larger in diameter than fitting opening.
9. Cleanouts at bases of downspouts shall be tapped soil tees with brass plugs as hereinafter specified, full size of line.
10. Cleanouts extended to grade in exterior sewer lines other than floors or concrete areas shall be a cleanout assembly with secured top, extra heavy-duty, adjustable sleeve, cut-off ferrule, countersunk threaded brass plug and scoriated tractor type cover.
11. Other cleanouts shall be iron body type.
12. Cleanout extensions shall be no-hub cast iron soil pipe. Exterior cleanouts, those in concrete excepted, shall terminate in a 14-inch by 6-inch thick concrete block with cleanout assembly and top of block flush with finish grade.
13. Fittings in lines utilized as cleanouts shall be approved soil fittings including no-hub pipe. Tees and crosses in vent headers excepted.
14. Pipe joint compound shall not be installed on cleanout plug. After lines are tested and approved, each cleanout plug shall be removed, greased, and replaced.

### 3.03 EXCAVATION, TRENCHING AND BACKFILLING

- A. Perform trenching, excavation, and backfilling required for Work of this section as specified herein and in Section 31 2323: Excavating, Backfilling, and Compacting for Utilities.

### 3.04 SERVICE CONNECTIONS

- A. Determine exact location of required water, drain, and sewer connections and provide proper connections.
- B. Potable water lines shall be purged completely before connecting to sources of water for the Project. Determine quality of water supply before connection.

### 3.05 WATER HAMMER ARRESTORS

- A. Install water hammer arrestors indicated on Drawings and in following locations (only non-ferrous arrestors may be installed in copper water system):
  - 1. Water lines to lavatory headers, water closet and urinal headers, service sinks, kitchen sinks, wash fountains, drinking fountains, laboratories with medical type faucets and on wash sinks having three or more stations and all other quick closing fixture such as clothes washers, as close to fixture as possible.
  - 2. Between last two fixtures when three or more fixtures, other than those listed in Number 1 above, are served by a common header.
- B. When possible, arrestor shall be installed in wall or furring. When arrestor is installed in wall or furring, furnish an access plate large enough to permit removal of arrestor. Access plate shall be a minimum of 2 inches larger in each direction than the arrestor.
- C. Fixture water lines shall be provided with mechanical water arrestor hammer dampening devices. Air chambers are not approved.

## 3.06

## CONDENSATE DRAINS - FROM AIR CONDITIONING UNITS

- A. Connect drain piping from drain pan of air conditioning unit to condensate disposal location indicated. When coil or unit housing is shock or vibration isolated, connection shall be furnished through a flexible connector not less than 10 inches long. Drain line shall pitch to flow out at not less than one inch in 8 feet. Drain line size shall be per UPC (3/4 inch up to 3 ton only). Drain line shall not be reduced smaller than unit outlet connection.
- B. Condensate drain piping installed within building whether in air conditioned space or not shall be insulated. Refer to Section 22 0700: Plumbing Insulation, for type of material required.
- C. Condensate Trap:
  - 1. A condensate trap shall be installed for each air conditioning coil. Trap shall be assembled from 2 brass unions: one between A/C unit and inlet of trap, and one at outlet of trap that connects to main drain.
  - 2. Trap configuration shall be per manufacturer's recommendations based on total unit casting static pressure (simulated plugged filter condition), but not less than 3 inch water seal.
  - 3. Running trap design is not permitted.

- 4. Secondary drain shall not be trapped.
- D. Condensate trap shall be checked at equipment operational tests for proper water drainage flow from air conditioning unit. Cooling condensate pan shall be filled with water, filters covered with plastic (plugged filter simulated), unit panels replaced, and unit motor running at design condition. Pan shall drain without hesitation to bottom of inlet connection. Tests are made prior to installation of ceiling.
- E. Secondary Overflow Drain:
  - 1. Drain pan installed underneath air conditioning units in concealed ceiling space or units that incorporate dam fitting shall be furnished with secondary drain piped to outside planter area with outflow location clearly visible.
  - 2. If outside building location is not available or feasible, secondary drains shall be piped to a classroom sink, if sink is not available pipe to a room corner away from cabinets, computers, desks, door ways/entrances or stairs.
  - 3. Secondary vertical pipe that penetrates through suspended ceiling shall be furnished with a coupling or threaded adapter so ceiling tile can be removed without damage.

3.07 CONDENSATE DRAINS - FROM WINDOW TYPE HEAT PUMP AND EXTERIOR WALL MOUNT HEAT PUMP UNITS

- A. Whether indicated on Drawings or not, window units and wall mount units without built in bottom drain pan for evaporator and condenser coils shall be provided with galvanized steel condensate pan at bottom of unit with drain line that drains into drywell. Install copper 1/2 inch diameter pipe for window type air conditioners and 3/4 inch diameter pipe for exterior wall-mounted heat pump units.

3.08 MAKE-UP WATER SYSTEMS

- A. Provide and connect make-up water systems for equipment in other sections.

3.09 NOT USED

3.10 NOT USED

3.11 CLEANING - PLUMBING PIPING SYSTEMS AND FIXTURES

- A. Plumbing lines and fixtures shall be flushed to remove dirt and foreign material until water runs clear and no foreign substance or odor is present. Strainers and screens on faucets shall be removed during this cleaning operation.

- B. After satisfactory cleaning of strainer and screen replacements has been witnessed by the Project Inspector, post and maintain signs stating: "CAUTION - Water at this construction project has not yet been certified for human consumption." Signs shall be furnished with letters at least 1/2 inch in height, and shall be conspicuously posted at entrances to the Project site. Signs shall be paneled, black and yellow, in conformance with OSHA Section 1910.1455.

3.12 DISINFECTING DOMESTIC WATER PIPING SYSTEMS

- A. Newly installed or replaced piping and/or fixtures dispensing potable water shall be disinfected and undergo an approved bacteriological analyses before water system is allowed for public use.
- B. Work shall be performed by Technicians Certified by the American Water Works Association (AWWA) and/or the State of California Department Health Services, Grade II Water Treatment Operator Certification or higher issued by the Department of Health Services (DHS) for the State of California. Comply with Title 22, Code of Regulations Division 4, Chapter 13, and Article 2 Operator Certification Grades.
- C. Method:
1. A Reduced Pressure Backflow assembly shall be installed to protect from cross contamination of the local water purveyor's meter service supply when at any time there is any type of water connection with the piping to be disinfected (Chlorinated) and the water meter service supply.
  2. System is to be flushed to remove any materials that may have entered the system.
  3. Using a chemical feed metering pump and a chlorine tank, the chlorine solution is injected into the water system.
- D. Disinfection and De-chlorination procedure (24 or 3 Hour Contact Time):
1. 24-hour Test Method:
    - a. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
    - b. Piping system shall then be adequately flushed with water to remove any particles and eliminate air pockets.
    - c. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 50 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection

and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.

- d. Chlorine residual test will be taken at all appropriate points and outlets to verify 50 PPM residual levels.
- e. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 24 hours.
- f. After 24 hours, chlorine residual levels will again be tested at various points throughout the system to insure a minimum of 25 PPM residual. If the system has not met the minimum of a 25 PPM residual, the above disinfection process shall be repeated.
- g. After satisfactory completion of the residual testing, flush out system until Hach or equivalent test reveal the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.
- h. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating water system is not safe for consumption until laboratory results are complete and meet these specifications.

2. 3 Hour Test Method:

- a. If the water systems must be turned on for use as soon as possible, a 3 hours chlorine contact time to allow for disinfection is permitted with the OAR's approval.
- b. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
- c. Piping system shall be then adequately flushed with water to remove any particles and eliminate air pockets. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 200 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.

- d. Chlorine residual test will be taken at all appropriate points and outlets to verify 200 PPM levels. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 3 hours.
- e. After satisfactory completion of a 3 hour disinfection period, flush out system until Hach or equivalent test reveal the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.
- f. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating water system is not safe for consumption until laboratory results are complete and meet these specifications.

E. Bacteriological Test:

- 1. After final flushing and satisfactory results from the residual free chlorine concentration test, Bacteriological test samples shall be collected. The intent of the following is to provide insurance for an accurate representation to a complete Bacteriological test of the water system. At least two samples shall be taken from each floor of each building.
- 2. Bacteriological test samples shall be delivered to a State of California Department of Health Services Certified Laboratory to perform qualitative and quantitative bacterial analyses on the water samples for the presence of any Total Coliform bacteria and Plate Count. This count must be less than 500 cfu/mL.
- 3. The procedure shall be repeated if it shown by bacteriological examination made by an approved agency that the level of Disinfection does not meet these specifications.
- 4. After satisfactory results for the bacteriological test are provided to the OAR, warning sign or tags shall be removed.

3.13 VALVES ON PLUMBING SYSTEM

- A. Furnish and install gates, ball, globes, angles, and check valves on plumbing Work at following locations whether indicated on drawings or not.
- B. Hot and cold valves shall be:
  - 1. Lead free complying with AB1953.

2. Above the ground copper water system, 2-inch and larger, may utilize Victaulic butterfly valves and fittings for their connections. A 2-inch or larger Victaulic valve may be in a wall if an adequately sized access panel is provided for maintenance or removal.
- C. Valves shall be accessible and installed within an access panel approximately 3 feet above floor and no more than 7 feet above floor, or in a marked yard box to prevent tampering.
  1. Immediately after each water meter, in addition to any valve furnished by utility company, there shall be an accessible valve on the inlet side for a strainer assembly, dual backflow device assembly and/or possibly a dual pressure reducing valve assembly.
  2. A gate or ball valve on each water supply before it enters building. Valves shall be accessible from outside building and shall be installed in a marked yard box, unless otherwise indicated on drawings. Ball valves 2 ½-inch size or larger shall omit gate valve handle and furnish 2-inch square operating nut.
  3. At multi story buildings, provide an isolation-valve or multiple valves for both hot and cold water in access panel to isolate and control each floor level.
  4. For classrooms, shops, offices and boiler or mechanical room, install a gate or ball valve to control hot and cold water lines to each group of fixtures, a group of fixtures shall be considered to be 2 or more fixtures in the same room. When practical, valves shall be installed on the same wall as group of fixtures. Valves shall control only fixtures in rooms in which they are installed.
  5. For restrooms, a gate or ball valve shall be installed in each restroom to isolate the hot and cold water supply into a restroom regardless of the number of fixtures. These valves shall control and be accessible only from within the restroom in which fixtures are installed. Valves shall be installed on the same wall as the group of fixtures it serves. Valves shall control only fixtures in restroom in which they are installed. Back to back restrooms shall be isolated separately and individually.
  6. Install a gate or ball valve on each building branch line, which serves two or more fixtures, when these fixtures are not provided with a group isolation valve as specified above. These valves shall be located approximately 3 feet but not more than 7 feet above finish floor.
  7. Install a gate, ball valve or partition stop for a drinking fountain or a group of drinking fountains.

8. Install a gate, ball valve or partition stop for hot and cold water supply to plumbing fixtures with no accessible supply stops, such as wall mounted faucets.
9. Install a gate, ball valve or partition stop for stops adjacent to, and controlling water flow to each sill cock and hose bib except as follows:
  - a. A sill cock immediately below an exterior drinking fountain may be controlled by the same gate, ball valve or partition stop as drinking fountain.
  - b. Valves or stops will not be required for individual hose bibs when these hose bibs are on a branch line serving only hose bibs and branch line is furnished with a shut-off valve.
10. Install a loose key angle stop, on each exposed fixture supply, and for each flush valve unless otherwise specified,
11. Install gate or ball valve at each location where a water line is connected to a piece of equipment other than items mentioned above.
12. Install a check valve on each hot water return line where it connects to a hot water storage tank or a water heater.
13. Handles, hand wheels (including dishwasher fill valve handles) and operating nuts shall be furnished of steel, brass, or cast iron and shall be removable. Unless specified to be loose key type, handles shall be securely fastened to their stems. On exposed outdoor valves, omit operating handles and provide operating nuts.
14. Provide a handle or a key for each five, or fraction thereof, loose key valves, bibs, or stops and deliver them to the project OAR.

3.14 NOT USED

3.15 ELECTROLYSIS PREVENTION

- A. Brass nipples, 6 inches, with recognized brass unions; flanges shall be furnished and installed at locations described herein. Flanges shall be installed with complete insulating component consisting of gasket bolt sleeves and bolt washers. Dielectric insulators shall be installed at following locations:
  1. Where special applications indicated on Drawings require an insulation flange or brass union, with 6-inch brass nipple to be installed in a condensate line, or steam line, flange insulation shall be of a high temperature type, suitable

for continuous operation at temperatures up to 220 degrees F. for condensate and 400 degrees F. for steam.

2. Where steel or cast iron in ground connects to copper or brass piping above ground, transition from steel or cast iron pipe to copper or brass pipe shall be provided in an accessible location.
3. Underground dielectric connections shall be furnished in accessible yard boxes.
4. Above ground dielectric connections shall be exposed; or if in finished rooms shall be located in accessible access boxes.

### 3.16 UNDERGROUND PIPE MARKERS

- A. Pipe markers shall be furnished according to Section 22 0553: "Plumbing Identification"
- B. Under ground Caution Tape shall be placed 12 to 18 inches above the utility line. The Caution Tape shall be a designated color and marked with the appropriate name for the specific type of utility pipe as follows:
  1. Yellow – with the words: CAUTION GAS LINE BELOW
  2. Blue – with the words: CAUTION WATER LINE BELOW

### 3.17 NOT USED

### 3.18 NOT USED

### 3.19 NOT USED

### 3.20 DEPTH OF SEWER LINES

- A. Minimum depth of below grade sewer lines shall be 24 inches to centerline of pipe. Sewer lines shall slope  $\frac{1}{4}$  inch per foot minimum, unless otherwise indicated. Minimum depth at Owner property line shall be 6 feet, unless otherwise required.

### 3.21 BACKFLOW PREVENTION DEVICES

- A. Backflow Devices: Installation of backflow devices shall be tested and certified by Los Angeles County backflow device tester before Substantial Completion. Tests shall be performed in presence of Project Inspector. Test reports shall be turned over to Project Inspector for mailing to proper agency.

3.22 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose off Project site.

3.23 PROTECTION

- A. Protect Work of this section until Substantial Completion.

END OF SECTION

## SECTION 26 0126

## TEST AND ACCEPTANCE REQUIREMENTS

**PART 1 - GENERAL****1.01 SUMMARY**

A. Principal items of work in this section include but are not limited to:

1. Ensure quality assurance, testing and final acceptance requirements for premises cabling installations comply with industry standards and Project Construction Documents.
2. The Los Angeles Unified School District (LAUSD) seeks to improve the quality of its network installations. In order to achieve this objective, the guidelines specified below are to serve as a technical reference for the Owner's infrastructure verification of the Installer's testing. The appendix of this section describes specific test procedures that the Owner shall perform during the acceptance testing, particularly those involving LAN, PABX, VTC, Convergence and WLAN equipment, and associated cable plants. The procedures provide a comprehensive series of visual, electronic, and optical tests to ensure the infrastructure installation complies with the standards set forth in the specifications. The successful culmination of these tests shall be used to document a physical configuration audit (PCA) as part of the Owner's Quality Assurance (Q/A) Report. Testing shall include physical Q/A review of installation and performance testing of components.

B. Responsibilities for this specification are as follows:

1. Installer: The Installer shall follow CEC, CANSI/EIA/TIA and BICSI installation standards. The Installer shall perform horizontal cable installation including Category 5e and Category 6a unshielded twisted pair (UTP) cable runs terminated in the communications cabinet and cable terminations at each work area outlet, as well as vertical cable installation, including fiber optic cable runs and terminations. During installation the Installer shall perform tests as required by the Parent Specification and in compliance with testing standards found in Appendixes B, C, and D of this Section. The Installer shall notify the Project Inspector 48 hours in advance of any required testing so that the Project Inspector can notify the Owner's Quality Assurance Team to observe the Installer's test procedures. The Installer shall forward test documentation to the OAR prior to the Owner's formal acceptance testing.
2. Contractor's Site Responsibilities during formal Owner's Quality Assurance: During formal Owner's Quality Assurance, the Contractor and his/her

Subcontractor shall comply with testing standards and requirements detailed in Appendices A through F. Under the guidance of the Project Inspector and in coordination with the Owner's Quality Assurance Team, the Installer shall:

- a. Verify LAN connectivity and WAN extension cabling to MDF.
  - b. Configure the router(s) and switch(es) in compliance with the Contract Documents.
  - c. Aid the Owner's Quality Assurance Team with network cut over. (e.g., existing systems with internet connectivity and administration systems including but not limited to SIS and payroll)
  - d. Provide labor, materials, and testing equipment (e.g., Power Meter, OTDR) to correct any deficiencies with labeling, cable charts, terminations, and Installer supplied test results.
  - e. Provide keys and access to installed network equipment.
3. Owner's Quality Assurance Team Responsibilities: Using the procedures specified in the Appendixes of this guideline, the Owner's Quality Assurance Team shall verify that the infrastructure installed under the Contract complies with the installation standards detailed in the Specifications. Specifically, testing shall be performed by the Owner on vertical and horizontal cable (e.g., fiber optic, Category 5e UTP and Category 6a UTP) along with component installations performed under the scope of the overall infrastructure effort (e.g., Ethernet switches and routers). Generally, testing specifications and procedures cover the following:
    - a. Q/A review of equipment rack installation; including placement in the communications cabinets, attachment to the floor, and seismic bracing.
    - b. Q/A review of fiber terminations, patch panel installation, cable labeling, and cable bundling.
    - c. Q/A review of Category 5e and Category 6a, T568B terminations, including cable end connections at the patch panel and work area outlets.
    - d. Q/A review of the Contractor's Redlines for accuracy.
    - e. Industry standard for fiber optic, Category 5e and Category 6a cable performance testing.
    - f. Network equipment performance verification.
    - g. Uninterruptible power supply performance verification.

h. Communications cabinet layout and facility drop count verification.

C. Related Requirements:

1. Division 01 - General Requirements.
2. Section 00 7000: General Conditions.
3. Section 01 7700: Contract Closeout.
4. Section 06 1000: Rough Carpentry.
5. Section 26 0500: Common Work Results for Electrical.
6. Section 26 0513: Basic Electrical Materials and Methods.
7. Section 26 0526: Grounding and Bonding.
8. Section 26 0533: Raceways and Boxes Fittings and Supports.
9. Section 26 2416: Panelboards and Signal Terminal Cabinets.
10. Section 27 1513: Communications Wiring.
11. Section 27 1514: Communications Wiring.
12. Section 27 5115: Public Address and Intercommunication Systems.
13. Section 28 1600: Intrusion Detection Systems.
14. Section 31 2323: Excavation, and fill(Utilities).

D. Acronyms:

dB	Decibel
IDF	Intermediate Distribution Facility
ITD	Information Technology Division
LAN	Local Area Network
LAUSD	Los Angeles Unified School District
LDC	Local Distribution - Classroom
LDF	Local Distribution Facility
MDF	Main Distribution Facility
MPOE	Minimum Point of Entry
NVP	Nominal Velocity of Propagation
OAR	Owner Authorized Representative
PA	Public Address
PBX	Private Branch Exchange
QA	Quality Assurance

UTP	Unshielded Twisted Pair
VoIP	Voice over Internet Protocol
WLAN	Wireless Local Area Network

## 1.02 SYSTEM REQUIREMENTS

- A. Will be found in Parent Specification.

## 1.03 SUBMITTALS

- A. Will be found in Parent Specification.

## 1.04 CODES AND STANDARDS

- A. Telecommunications Industry Association (TIA)/Electronic Industries Association (EIA)-568, Commercial Building Telecommunications Cabling Standard, current issue.
- B. EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. ANSI/EIA/TIA-598-A, Optical Fiber Cable Color Coding, current issue.
- D. EIA/TIA-606 (2002), Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- E. EIA/TIA-607, Commercial Grounding and Bonding Requirements for Telecommunications.
- F. EIA/TIA-OFSTP-14A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
- G. ANSI/TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard, current issue.
- H. EIA/TIA-OFSTP-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
- I. American National Standards Institute (ANSI)/EIA/TIA-455-59, Field Testing
- J. FCC Part 68.50.
- K. National Electrical Manufacturer's Association (NEMA).
- L. National Fire Protection Association (NFPA), NFPA-70.
- M. CCR Part 3 - California Electrical Code (CEC).
- N. CCR Part 2 - Uniform Building Code (UBC).
- O. Building Industry Consulting Services International (BICSI) TDMM, most recent revision.
- P. Institute of Electrical and Electronic Engineers (IEEE).
- Q. Other Codes and Standards as defined in the Parent Specification.

**1.05 SYSTEM DESCRIPTION**

- A. System will be found in Parent Specification.

**1.06 QUALITY ASSURANCE**

- A. Will be found in Parent Specification.

**1.07 WARRANTY**

- A. Will be found in Parent Specification.

**PART 2 - PROCEDURES**

**2.01 EQUIPMENT INSTALLATION**

- A. The Installer is responsible for basic installation and cross connection of LAN equipment required by the Contract Documents. The Owner's Quality Assurance Team shall verify that basic installation is complete and functional.

**2.02 PUNCH LIST**

- A. Per OAR request, The Owner's Quality Assurance Team shall assist in the Punch List for IT and low voltage systems and provide it to the OAR.

**2.03 CLOSEOUT DOCUMENTATION**

- A. Will be found in Parent Specification.

**2.04 QUALITY ASSURANCE**

- A. Owner's Quality Assurance Test Schedule

1. The Project Inspector shall schedule the Owner's Quality Assurance test after review of the Installers complete Test Results of the school.

**PART 3 - EXECUTION AND INSTALLATION**

**3.01 INSTALLATION**

- A. Will be found in Parent Specification.

**3.02 OWNER'S QUALITY ASSURANCE CERTIFICATION AND TESTING**

- A. Will be found in Parent Specification.

**3.03 PROJECT RECORD DOCUMENTS**

- A. Will be found in Parent Specification.

**3.04 PROTECTION**

- A. Will be found in Parent Specification.

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3.05 CLEANUP

- A. Will be found in Parent Specification.

3.06 OWNER ORIENTATION

- A. Will be found in Parent Specification.

## ***LAUSD Quality Assurance Guidelines***

### **APPENDIX A - QUALITY ASSURANCE PROCEDURES**

#### **A.1 Overview of Quality Testing Procedures**

This appendix provides guidelines for visual Quality Assurance reviews of each site. The Owner's Quality Assurance Team shall examine the Work based upon the guidelines outlined in the following appendixes and their associated forms.

1. Communications Cabinet Review. Verify the design and compliance with contract documents. This may include: EIA/TIA and BICSI cabling practices, standard and specific labeling practices, and safe and logical equipment and wire management placement.
2. Cable Plant Review. Cabling from the Communications cabinet, at various points along the cable path, and in functional work areas for compliance with TIA/EIA installation specifications including TIA/EIA-568-B and TIA/EIA-569 and documents referenced therein and professional installation practices.
3. User Work Area Quality Assurance Review. Cabling at the user wall plate location in the functional work areas for compliance with TIA/EIA installation specifications including TIA/EIA-568-B and TIA/EIA-569 and documents referenced therein and professional installation practices.
4. Redline As-Built Documentation shall be compared to physical installation. Deviations shall be noted and the Quality Assurance procedure halted until discrepancies have been rectified.

#### **A.2 General Quality Assurance Guidelines**

The Owner's Quality Assurance Team visually reviews the installation to verify that cabling is supported properly. Cable trays or structural ties shall support cable. No cable shall have been installed in pathways near sharp edges or objects that might cause damage. Cable shall not be supported by, on, or attached to a dry wall ceiling, ceiling tiles, ceiling grid, routed over pipes, conduit, lighting fixtures, or other wiring. The Owner's Quality Assurance Team should be able to determine the total number of drops dispersed from each communications cabinet, the number of drops for each supported room, and the agreed-upon labeling scheme for the site. The Installer should have met the following general labeling guidelines:

1. Clearly labeled each drop number and Communications cabinet on the wall jack faceplate.
2. Label each horizontal cable jacket using a permanent label at the workstation end, inside the wall, and the patch panel end no more than two inches from each end.
3. At workstation end: communications cabinet, drop, and termination panel.
4. At patch panel end: drop and cabinet numbers.

## ***LAUSD Quality Assurance Guidelines***

5. Label each patch panel port with drop number and cabinet number.

Because work area room numbers may have been modified since the design, the installer shall provide as built documentation for each communications cabinet; reflecting the room numbers used in the labeling scheme as a reference point. The Contractor and his/her Subcontractor shall use these working prints to produce post-installation as-built drawings.

### **A.3 Deficiency Reports**

Before beginning any test, the Owner's Quality Assurance Team shall view any deficiency report(s) (DR) that have been filed with the OAR and Project Inspector. The Owner's Quality Assurance Team shall review the DR(s) as part of the Quality Assurance review to ensure the required corrective actions have been taken.

### **A.4 Quality Assurance Test Procedures**

The Owner's Quality Assurance Team shall follow the acceptance test and performance criteria outlined in TIA 568B, OFSTP-14A, OFSTP-7 and shall conduct acceptance and performance testing following each manufacturer's specification on their respective network components to verify compliance with manufacturer's installation instructions.

The Owner's Quality Assurance Team shall also follow any specific local policy directives or instructions regarding installation practices and/or acceptance testing identified during the site orientation visit. The details for the design of a particular location shall also comply with any related State, County and Municipal standards.

### **A.5 Construction Quality Assurance of Work:**

During the installation of low voltage systems, upon request by the OAR, the Owner's Quality Assurance Team shall examine the following:

1. General to Low Voltage Systems:
  - a. Conduit and raceway layout and installation for each low voltage system and verify that they meet project specifications.
  - b. Equipment rack installation, including placement in the communications room, seismic bracing, and attachment to the floor.
  - c. Cable punch-downs, patch panel installation, cable cross-connection, cable labeling, and cable bundling.
  - d. Verify proper equipment installation, cable cross connection, system configuration, and testing.
  - e. Verify system layout and device location(s) match the locations shown on the as-builds.

## ***LAUSD Quality Assurance Guidelines***

- f. Active components, terminal cabinets, cross connects, splices, etc. are located in a secure interior location.
  - g. Verification of Uninterruptible power supply performance.
  - h. Verification of proper air conditioning in MDF and IDFs. Room temperature should maintain between 65 - 72 degrees 7 days per week, 24 hours per day.
  - i. Terminations punched down singly and cross-connected on 66 blocks. 66 blocks are primarily used in Public Address systems and Intercom. PBX cable plants are specified to use 110-blocks exclusively.
2. LAN, verify the following:
    - a. Examine Category 5e and Category 6a, T568B terminations, including cable end connections at the patch panel and wall drop receptacles.
    - b. Examine fiber terminations and fiber termination boxes.
    - c. Examine Installer's basic network components installation and operation.
    - d. Review customized configuration and test results.
    - e. Test overall network operation to ensure it meets Owner's strategic planning and acceptable performance level.

### **A.6 Start Up**

Start-up work is to be completed as a condition for Substantial Completion. Start-Up is to include the testing and commissioning of equipment and systems.

1. After start up has been completed but prior to Substantial Completion, the Project Inspector shall schedule the Owner's Quality Assurance Team site visit.
2. The Owner's Quality Assurance Team shall review documentation and test results for completeness.
3. The Owner's Quality Assurance Team shall visit the site and verify the Contractor's test results by the Quality Assurance procedures detailed herein.

### **A.7 Contract Completion and Process Review**

The Quality Assurance Team shall review the entire Quality Assurance process and recommend changes to improve it on an as needed basis.

### **A.8 Test Procedures**

## ***LAUSD Quality Assurance Guidelines***

1. Visual Q/A Reviews
  - a. The Owner's Quality Assurance Team shall conduct a visual review of the installation including the communication cabinet, cable runs, and user work areas. Appendix A documents these Q/A review procedures.
2. Cable Performance Testing
  - a. The Owner's Quality Assurance Team shall test 100% of the fiber optic Backbone cable, a random sample of Category 5e and Category 6a UTP cable and the fiber optic Horizontal cable. Appendix C outlines these specific tests.
    - (1) Test Cable Sampling: The Owner's Quality Assurance Team shall randomly test 10% of installed horizontal cables from each communication cabinet on site. For example, if a communications cabinet has 100 drops, the Owner's Quality Assurance Team shall test a minimum of 10 drops for each cabinet. Where random testing shows a failure rate of more than 1% of the drops (2 in 10 of the random sample), an additional 10% of the installed horizontal cabling shall be tested. Appendix B outlines these specific tests.
    - (2) Cable Testing: The Owner's Quality Assurance Team shall perform the following industry-standard operational and performance cable testing detailed in TIA/EIA 568B.1:
      - (a) Wire map
      - (b) Length verification
      - (c) Insertion loss (attenuation)
      - (d) Near-end crosstalk (NEXT)
      - (e) Power sum near-end crosstalk (PSNEXT)
      - (f) Equal level far-end crosstalk (ELFEXT)
      - (g) Power sum equal level far-end crosstalk (PSELFEXT)
      - (h) Return loss
      - (i) Propagation delay
      - (j) Delay skew
3. Network Equipment Testing

## *LAUSD Quality Assurance Guidelines*

- a. The Owner's Quality Assurance Team shall perform network tests on hardware components for proper installation, per manufacturer's recommendations and configuration. Components shall be tested separately for initial power up and their ability to maintain system configuration. The specific test for network equipment components is described in Appendix D.

### **A.9 Acceptance Criteria**

1. An overall Pass or Fail condition shall be determined by the results of the required individual test. Any Fail and Fail\* shall result in an overall Fail. In order to achieve an overall Pass condition, individual results shall be Pass or Pass\*. A Pass or Fail result for each parameter is determined by the allowable limits for that parameter. The test result of a parameter is marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer shall provide documentation as an aid to interpret results marked with asterisks.
2. Cable plant acceptance by the Owner requires 100% passing results for cable samples and corrected cabling deficiencies. Acceptance of other components is based upon satisfactory completion of a test configuration scenario, as defined in the appropriate appendix to this plan.

### **A.10 Corrective Procedures**

1. EIA/TIA testing specification details a pass/fail criterion, i.e., if a fiber optic cable is outside of specifications, the test fails. The Owner's Quality Assurance Team shall identify any deficiencies found during Quality Assurance (e.g., a cable or component failing a test) to site personnel before the Owner's Quality Assurance Teams departure and shall document these deficiencies in the Quality Assurance Report. If the link attenuation for any fiber optic cable strand is outside acceptable loss as specified in TIA/EIA-568-B, the Installer shall re-complete the terminations required to reduce the amount of attenuation. If re-termination fails, the Installer shall be required to take steps up to and including the replacement of the cable to eliminate the testing deficiency. After corrective action, the Owner's Quality Assurance Team shall retest repaired fiber runs and document the results in the Quality Assurance Report.
2. The Owner's Quality Assurance Team shall identify to the Owner in writing any deviation from acceptable EIA/TIA specifications for cabling resulting in a test failure. The Owner may choose to accept the deficiency via a written waiver. For example, if a fiber optic connection exceeds the allowable termination attenuation by 0.1 decibels (dB), but the total link attenuation is within the length attenuation budget, the Owner may choose to waive the specification. Other components (e.g., switches or routers) must function according to the specified configurations in the final Work Plan for Owner LAN projects.

***LAUSD Quality Assurance Guidelines***

**A.11 Quality Assurance Reporting**

1. Acceptance Recommendation
  - a. At the conclusion of testing, the Owner's Quality Assurance Team shall provide a recommendation to Owner to accept or not accept the installation.
2. Quality Assurance Report
  - a. The Owner's Quality Assurance Team shall deliver a Quality Assurance Report to the project OAR no later than seven (7) working days after completion of testing. This report shall include:
    - (1) A written test report for visual installation tests.
    - (2) Electronic test results of cable testing including verified cable lengths, test personnel, test date, and individual test description.
    - (3) Each detected deficiency with its correction date and retest results, if accomplished.
    - (4) Network operational test results for the switch(s) and router connections.
    - (5) Any condition(s) precluding strict adherence to NEC, EIA/TIA, and BICSI installations or Quality Assurance standards shall be marked for potential Owner waiver before system acceptance.
    - (6) A summary confirming the acceptance recommendation given.

**A.12 Test Equipment**

1. The Owner's Quality Assurance Team shall use the following test equipment or their equivalent during testing.
  - a. Fluke DSP 4300 Level III, or equal, tester with single-mode and multi-mode power meter and light source heads.
  - b. Fluke Optifiber Optical Time Domain Reflectometer (OTDR)
  - c. Personal computer with Transmission Control Protocol/Internet Protocol (TCP/IP) protocol stacks.
  - d. Thermometer

***LAUSD Quality Assurance Guidelines***

Table 2.6.1 T & A Checklist for Owner's Quality Assurance Team Projects

Site Location Code / Name	OAR
Network Engineer	Insp ector
OAR Recommendation	Electrical Inspector

Review Item	Yes	No	N/A	Pass/Fail
Have deficiencies been cleared by the Project Inspector or OAR?				
Has the vendor provided cable charts in the cabinets?				
Are there any horizontal cables over 90m?				
Do the cable runs used agree with the cable routing drawings?				
Are the cables routed and terminated per specification?				
Are cable run penetrations terminated to preclude strain on the installed cable?				
Are the copper and fiber optic cables installed per the manufacturer's recommendation?				
Is each cable clearly labeled at the user's location?				
Is each port on the patch panel labeled with the corresponding user outlet location?				
Are cable and patch panel labels securely fastened and easily readable?				
Are the fiber cables in the fiber termination box labeled per the approved labeling scheme and immediately adjacent to each termination within the fiber termination box?				
Is the cable for each drop identified with the correct labeling scheme at or near the point of termination?				
Does the user outlet plate display the correct labeling scheme and match the distant end label?				
Are connectors free of exposed metal, loose connectors, or other problems?				
Is the cable jacket stripped back only as far as required to terminate on connecting hardware?				
Is the physical plant installed in accordance with specifications of this project?				
For traditional, hierarchical star cable plants following 25568 specifications, are there at least 50% spare Backbone strands, in multiples of 6 strands, to each IDF from the MDF ?				
For new fiber optics cable plant installations following 25569				

### ***LAUSD Quality Assurance Guidelines***

specifications, are there at least 15 percent spare Backbone strands, in multiples of 6 strands, to each IDF from the MDF ?				
Does this site have an existing Local Area Network?				
Is the T1 line correctly installed and ready to cut over? Also, has the extension to the MDF been installed?				
Will the site reutilize an existing router? If yes, specify exact model / serial number.				
Is the router configured and ready for cut over?				
Are the required amounts of GB Uplinks provided to accommodate the equipment installed including port expansion?				
Are classroom and administration switches mounted, connected, and operational?				
Has the vendor provided inventory and the drop count been verified or has an Inventory document been completed? If so, please attach.				

#### **A.13 Visual Q/A Review Worksheets**

The following pages provide the three visual Quality Assurance worksheets:

1. Communications Cabinet Quality Assurance Review Form
2. Cable Routing Quality Assurance Review Form
3. User Work Area Quality Assurance Review Form

***LAUSD Quality Assurance Guidelines***

**A.13.1 Communications Enclosure Quality Assurance Review Form**

Site _____	Date _____	Quality Assurance Rep(s) _____
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<b>Q/A REVIEW ITEM</b>	<b>PASS</b>	<b>FAIL</b>
Is the cabinet ready for a Q/A review? If not, list discrepancies (e.g., debris, punch-list, or un-terminated cable).		
Is the installation performed in the planned communications cabinet?		
Are there clearly identified final or redlined drawings showing the "as-built" installation?		
With all devices operating, are ambient cabinet and room temperatures within 50-80° F? The temperature is: _____.		
Are heating, ventilation, and air conditioning (HVAC), lighting, and electrical outlets installed per contract? Are the requirements addressed in the Site Concurrence Memorandum or other documentation?		
Are cabinet rails and wire managers installed so as to preclude any space problems with the UPS?		
Are the cabinets seismically braced to the floor and/or wall?		
Is there adequate space around the racks and fiber termination panel for maintenance?		
Are patch panels, wire management panels, and network equipment properly affixed to the rack?		
Is debris cleaned from inside of cabinets?		
Are cable run penetrations installed so fire barriers are maintained in cabinet locations?		
Are cable run penetrations properly and securely fastened to supporting structures?		
Are cable run penetrations terminated to preclude strain on the installed cable in cabinet locations?		
Are cables routed and punched per specification and industry standards?		
Is each cable clearly labeled with the corresponding user location per specification?		
Is each port on the patch panel labeled with the corresponding user location per specification?		
Are cable and patch panel labels securely fastened and easily readable per specification?		
Is there ½-inch or less of untwisting on any cable pair at the termination point?		
Is the UTP cable jacket stripped back only as far as required to terminate on connecting hardware?		
Is a bend radius of at least 1-inch maintained for sheathed UTP cable?		
Is the fiber optic cable free from excessive strain or stress, sharp bends, or kinks?		
Are service loops in place at each end of the cable?		
Are the fiber cables in the fiber termination unit? Is the box labeled per the approved labeling scheme and immediately adjacent to each termination within the fiber termination		

***LAUSD Quality Assurance Guidelines***

box?		
Is excess fiber optic cable coiled in the termination box so it does not exceed the minimum bend radius per manufacturer's recommendations and specifications?		
Are fiber optic patch cords neatly routed to the network equipment via wire management?		

**A.13.2 Cable Routing Q/A Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_

Q/A REVIEW ITEM	PASS	FAIL
Are cable bundles either secured to the wall or to a non-electromagnetic interference-producing source or hung from the ceiling (e.g., suspended via cable trays, inner duct, J-hooks, D-rings, or ladder rack) per specification or best industry standards?		
Do the cable runs used agree with the redline drawings?		
If not, are accurate redlined drawings available showing the cable routing?		
Is debris from the cable run penetrations adequately cleaned up per specification?		
Is the fiber optic cable runs completely contained within inner duct? Where?		
<b>Notes:</b>		

**LAUSD Quality Assurance Guidelines**

**A.13.3 User Work Area Q/A Review Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_

<b>Q/A REVIEW ITEM</b>	<b>PASS</b>	<b>FAIL</b>
Are wall jack faceplates professionally installed and finished?		
Is cabling precluded from view on the external surface of walls (e.g., ducting used on solid core walls)?		
Does the user outlet plate display the correct labeling scheme?		
Is the cable for each drop identified with the correct labeling scheme and within 2 inches of termination per specification?		
Is the cable installed in a manner that precludes cable strain?		
Are connectors insulated from surrounding cable and objects (e.g., are cable barrel adapters, connectors, devices, and terminators insulated from any earth ground or current-conducting surfaces of the building structure)?		
Are connectors free of exposed metal, loose connectors, or other problems?		
Is there $\frac{1}{2}$ -inch or less of untwisting on any cable pair at the termination point?		
Is the cable jacket stripped back only as far as required to terminate on connecting hardware?		
Is a bend radius of at least 1-inch maintained for sheathed UTP cable?		
Is the 4 or 6 strand fiber secured properly in the LDFs and LDCs?		
<b>Notes:</b>		

## ***LAUSD Quality Assurance Guidelines***

### **APPENDIX B - CATEGORY 5E AND CATEGORY 6 UTP CABLE PERFORMANCE TESTS**

#### **B.1 Overview of Cable Tests**

This appendix provides guidelines for electronic testing of Horizontal Category 5e UTP wiring. The Owner's Quality Assurance Team shall meet the guidelines outlined in the following Q/A review and its associated forms.

- Electronic Testing. This testing verifies that the standard performance parameters for the UTP cable as outlined in TIA/EIA 568-B are within the specifications as noted below. TIA/EIA 568-B addresses specific field-tests for post-installation performance measurements of the designed cable plants. Owner only uses Category 5e, or Category 6a UTP cables for its LAN installations. Refer to Premise Wiring Specification.

#### **B.2 Test and Support Equipment**

1. The types of cable to be tested are as follows :
  - a. Category 5E UTP shall be tested based on TIA/EIA 568-B.1 section 11.2.3 specifications
  - b. Category 6a UTP shall be tested based on TIA/EIA 568-B.2-1

**Note:** Sections B2 through B6 address Category 5E related tests, requirements, and specifications. Sections B7 through B11 address Category 6a related tests, requirements, and specifications.

#### **B.3 Electronic Tests**

The Owner's Quality Assurance Team randomly selects cables for testing and every effort shall be made to avoid a typical testing pattern from communications cabinet to work area outlet, so that no testing pattern is discernible. The testing personnel shall inspect drops on the faceplate in multiple cases to ensure cables are labeled and no cross connects are visible, etc. The testing personnel shall perform a Q/A review of the cable termination(s) in the Communications cabinet(s) and the corresponding user location of selected cables (e.g., the faceplate labels or terminations behind the termination panel). The personnel must be consistent in testing selected cables.

The *permanent* link test configurations described in TIA/EIA 568-B.1 section 11.2.4.1, performance parameters include wire map, length, Insertion loss (attenuation), NEXT, PSNEXT, ELFEXT, PSELFEXT, Return loss, Propagation delay and Delay Skew for 100 W 4-pair Category 5e cabling. 568-B.1 section 11.2.4.3 thru .11 identifies acceptable ranges of test results, test equipment checks, diagnostic information, and specific test procedures.

TIA/EIA 568-B.1 section 11.2.4.1, also specifies laboratory measurement methods, component and field test methods and computation algorithms over the specified frequency range. To ensure verifiable equipment calibration, the Owner's Quality

## *LAUSD Quality Assurance Guidelines*

Assurance Team shall certify test equipment accuracy in compliance with 568-B.1 section 11.2.4.3 thru .10 each time a new list of tests is performed.

The Owner's Quality Assurance Team shall consider cable(s) and cabling components as pre-tested by the manufacturer to meet TIA/EIA-568-B Category 5e specifications. Therefore, individual testing of connectors and other cabling components is not required.

### **B.4 Data Accuracy**

Tests shall be conducted on the premise that TIA/EIA-568-B and other applicable specifications were applied to the cable installation. Further, the Owner's Quality Assurance Team shall be provided the test result book to verify the Installer tested 100 percent of their work, so the sampling tests performed ensures system operability and customer satisfaction.

### **B.5 Data and Test Reporting**

The Quality Assurance Report shall clearly identify the test environment, test equipment used, name of each tester, acceptable results (as specified in 568-B), and actual results for each test performed. If a failure occurs, the test shall proceed, with the failure reported to the responsible Installer for repair at test end.

## **B.6 Communications Wiring Electrical Tests**

### **B.6.1 Wire Map**

Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

### **B.6.2 Length**

The field tester shall be capable of measuring length of all pairs of a permanent link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay.

This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

### **B.6.3 Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz, through the highest applicable frequency. It is preferred to measure insertion loss at the same frequency intervals as NEXT

## ***LAUSD Quality Assurance Guidelines***

Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.

Minimum test result documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

### **B.6.4 NEXT Loss**

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the highest applicable frequency. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case).

**Table 1**

<b>Frequency Range (MHZ)</b>	<b>Maximum Step Size (MHz)</b>
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50

NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.5 PSNEXT Loss**

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of 8 results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 MHz through the highest applicable frequency and the step size may not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst

## *LAUSD Quality Assurance Guidelines*

value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.6 ELFEXT Loss, pair-to-pair**

Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through the highest applicable frequency and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as in Table 1, column 2. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.7 PSELFEXT Loss**

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations.

Each wire-pair is evaluated from 1 MHz through the highest applicable frequency in frequency increments that do not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.8 Return Loss**

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the highest applicable frequency in increments that do not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

## ***LAUSD Quality Assurance Guidelines***

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.9 Propagation Delay**

Propagation delay is the time required for the signal to travel from one end of the link to the other.

This measurement is to be performed for each of the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

### **B.6.10 Delay Skew**

This parameter shows the difference in propagation delay between the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pairs with the worst-case propagation Delay skew. The report shall include the Delay skew value measured as well as the test limit value.

### **B.6.11 ACR (Attenuation to crosstalk ratio)**

This parameter is not required by TIA standards but may be expected in order to obtain the premise wiring manufacturer's warranty.

ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.12 PSACR**

This parameter is not required by TIA standards but may be required in order to obtain the premise wiring vendor's warranty. The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

***LAUSD Quality Assurance Guidelines***

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

LAUSD Quality Assurance Guidelines

B.7 Communications Wiring Electrical Test Form

Site

Date

---

Building and Communications Room Numbers

Q/A Rep(s)

Date \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_

### **B.8 Electronic Tests**

The Owner's Quality Assurance Team randomly selects cables for testing and every effort shall be made to avoid a typical testing pattern from communications cabinet to work area outlet, so that no testing pattern is discernible. The testing personnel shall inspect drops on the faceplate in multiple cases to ensure cables are labeled and no cross connects are visible, etc. The testing personnel shall perform a Q/A review of the cable termination(s) in the Communications cabinet(s) and the corresponding user location of selected cables (e.g., the faceplate labels or terminations behind the termination panel). The personnel must be consistent in testing selected cables.

The **permanent link** test configurations described in TIA/EIA 568-B.2-1, performance parameters include wire map, length, Insertion loss (attenuation), NEXT, PSNEXT, ELFEXT, PSELFEXT, Return loss, Propagation delay and Delay Skew for 100 W 4-pair Category 6a cabling. 568-B.2 identifies acceptable ranges of test results, test equipment checks, diagnostic information and specific test procedures as related to Category 6a cabling. TIA/EIA 568-B.2-1 also includes laboratory measurement methods, component and field test methods, and computation algorithms over the specified frequency range. The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in TIA/EIA 568-B.2-1. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy *plus* adapter contribution) are specified in Table B.2 of Annex B of the TIA/EIA 568-B.2-1 standard. (Table B.3 in this TIA document specifies the accuracy requirements for the Channel configuration.)

The Owner's Quality Assurance Team shall consider cable(s) and cabling components as pre-tested by the manufacturer to meet TIA/EIA-568-B.2-1 Category 6a specifications. Therefore, individual testing of connectors and other cabling components is not required.

### **B.9 Data Accuracy**

Tests shall be conducted on the premise that TIA/EIA-568-B.2 and other applicable specifications were applied to the cable installation. Further, the Owner's Quality Assurance Team shall be provided the test result book to verify the Installer tested 100 percent of their work, so the sampling tests performed ensures system operability and customer satisfaction. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not

## *LAUSD Quality Assurance Guidelines*

cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

### **B.10 Data and Test Reporting**

The Quality Assurance Report shall clearly identify the test environment, test equipment used, name of each tester, acceptable results (as specified in 568-B Category 6a related), and actual results for each test performed. If a failure occurs, the test shall proceed, with the failure reported to the responsible Installer for repair at test end.

### **B.11 Communications Wiring Electrical Tests**

The test parameters for Category 5e and Category 6a are defined in TIA/EIA-568-B.2 standard. The test of each link shall contain of the following parameters as detailed below. In order to pass the test, measurements (at each frequency in the range from 1 MHz through 350 MHz) must meet or exceed the limit value determined in the above-mentioned standard.

#### **B.11.1 Wire Map**

Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

#### **B.11.2 Length**

The field tester shall be capable of measuring length of pairs of a permanent link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation. The physical length of the link shall be calculated using the pair with the shortest electrical delay.

This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

#### **B.11.3 Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz, through the highest applicable frequency. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.

Minimum test result documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the

## *LAUSD Quality Assurance Guidelines*

highest attenuation value measured (worst case), the frequency at which this worst case value occurs and the test limit value at this frequency.

### **B.11.4 NEXT Loss**

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the highest applicable frequency. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case).

**Table 2**

Frequency Range (MHz)	Maximum Step Size (MHz)
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50
250-350	1.00

NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.11.5 PSNEXT Loss**

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of eight results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 MHz through the highest applicable frequency and the step size may not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.11.6 ELFEXT Loss, pair-to-pair**

Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through the highest applicable frequency and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.11.7 PSELFEXT Loss**

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations.

Each wire-pair is evaluated from 1 MHz through the highest applicable frequency in frequency increments that do not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.11.8 Return Loss**

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the highest applicable frequency in increments that do not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests

## *LAUSD Quality Assurance Guidelines*

performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.11.9 Propagation Delay**

Propagation delay is the time required for the signal to travel from one end of the link to the other.

This measurement is to be performed for each of the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

### **B.11.10 Delay Skew**

As defined in TIA/EIA-568-B.1; Section 11.2.4.11, this parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero.

Minimum test result documentation (summary results): Identify the wire pairs with the worst-case propagation Delay skew. The report shall include the Delay skew value measured as well as the test limit value.

### **B.11.11 ACR (Attenuation to crosstalk ratio)**

This parameter is not required by TIA standards but may be expected in order to obtain the premise wiring manufacturer's warranty.

ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.11.12 PSACR**

This parameter is not required by TIA standards but may be required in order to obtain the premise wiring vendor's warranty. The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

***LAUSD Quality Assurance Guidelines***

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

LAUSD Quality Assurance Guidelines

## B.12 Communications Wiring Electrical Test Form

Q/A Rep(s) \_\_\_\_\_ Date \_\_\_\_\_  
Site \_\_\_\_\_

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***LAUSD Quality Assurance Guidelines***

**APPENDIX C - FIBER OPTIC CABLE PERFORMANCE TESTS**

**C.1 Overview of Cable Tests**

TIA/EIA-568-B.3 states, “The optical fiber cable construction shall consist of 50/125 mm or 62.5/125 mm multimode optical fibers or single mode optical fibers, or a combination of these media.” Multimode fiber shall have a graded-index optical fiber waveguide with nominal 50/125  $\mu\text{m}$  for installations following specification 27 1514, or 62.5/125  $\mu\text{m}$  core/ cladding diameter for installations following specification 27 1513. Primary and secondary backbone cable testing shall be equivalent to backbone cabling as defined in TIA/EIA-568-B.1 section 11.3.3, such as cabling interconnecting telecommunications closets, equipment cabinets, and entrance facilities. Therefore, the Owner’s Quality Assurance Team shall perform the following interrelated tests:

1. Verification of multi-mode fiber optic cable installations.
2. Verification of single-mode fiber optic cable installations.
3. Electronic measurement of the distance and equivalent attenuation per kilometer (km) to verify minimum data transmission capacity per specification.
4. Total link attenuation measurements.

**C.2 Test Equipment**

The following test equipment shall be used:

1. Fluke DSP 4300 Level III, or equal, tester with single mode and multi-mode power meter and light source heads
2. Fluke, or equal, OptiFiber Optical Time Domain Reflectometer (OTDR)

**C.2.1 Cabling Distance**

Section 27 1513 states that the maximum allowable multimode cable distance from MDF to IDF is 450 meters. The Multimode strands shall primarily be utilized by the network electronics up to 450 meters and testing shall conform to OFSTP-14A. The Singlemode strands shall be required where cabling the Backbone distance exceeds 450 meters and testing shall conform to OFSTP-7.

**C.2.2 Cable Attenuation**

The list below details the information presented in TIA/EIA – 568B.3 to illustrate the allowable attenuation per kilometer for 50/125, 62.5/125 and 9 $\mu\text{m}$  fiber.

**Table C.2.2-1. Maximum Cable Attenuation Coefficient for Backbone Fiber**

## *LAUSD Quality Assurance Guidelines*

MAXIMUM ATTENUATION RANGE	ALLOWABLE ATTENUATION
50/125 $\mu\text{m}$ @ 850nm	3.5 dB/km
50/125 $\mu\text{m}$ @ 1300nm	1.5 dB/km
62.5/125 $\mu\text{m}$ @ 850nm	.5 dB/km
62.5/125 $\mu\text{m}$ @ 1300nm	.5 dB/km
9 $\mu\text{m}$ @ 1310 nm (indoor)	1 dB/km
9 $\mu\text{m}$ @ 1550 nm (indoor)	1 dB/km
9 $\mu\text{m}$ @ 1310 nm (indoor)	1 dB/km
9 $\mu\text{m}$ @ 1550 nm (indoor)	1 dB/km

### **C.2.3 Connector Attenuation**

Per ANSI/EIA/TIA-455-59, the maximum optical attenuation per connector pair shall not exceed 0.75 dB.

## **C.3 Test Procedures**

For multi-mode fiber the Owner's Quality Assurance Team shall use the Omni Scanner 2 to test the length and total attenuation at both the 850 nm and 1300 nm wavelengths in each direction (bi-directionally). If the test fails, the Owner's Quality Assurance Team shall complete a repeat test using the OTDR to assess the failure point and address corrective actions. (See Methods A and B attached.)

For single-mode fiber, the Owner's Quality Assurance Team shall use a power meter and light source. The specific nanometer wavelength(s) at which the single-mode fiber shall be tested (i.e., 1310 nm and/or 1550 nm) shall be determined based on the length of the fiber cable being tested.

### **C.3.1 Cable Distance**

Using the Omni Scanner 2 or OTDR, the Owner's Quality Assurance Team shall determine the overall fiber optic cable length to ensure the cabling distance is within the maximum allowable length.

### **C.3.2 Attenuation**

TIA/EIA-568-B.1 section 11.3.3, states, "When installing components compliant with this standard, the single performance parameter necessary for performance testing is link attenuation." Also "The backbone optical fiber cabling link segment should be tested in one direction at both operating wavelengths, to account for attenuation deltas associated with wavelength.

1. 50/125  $\mu\text{m}$  backbone links shall be tested at 850 and 1300 nm in accordance with ANSI/EIA/TIA-526-14-A, Method B, with One "Reference Jumper."

## ***LAUSD Quality Assurance Guidelines***

2. 62.5/125  $\mu\text{m}$  backbone links shall be tested at 850 and 1300 nm in accordance with ANSI/EIA/TIA-526-14-A, Method B, with One “Reference Jumper.”
3. 9  $\mu\text{m}$  backbone links shall be tested at 1310 and 1550 nm in accordance with ANSI/EIA/TIA-526-7, Method A.1.”

The Owner’s Quality Assurance Team shall use the Omni Scanner 2 or OTDR to measure the attenuation due to fiber optic cable and connectors. The Owner’s Quality Assurance Team shall test and record attenuation at both 850nm/1300nm for each Multi-mode and 1310nm/1550nm for Single-mode fiber optic strand respectively terminated under this initiative. These tests shall be performed at each communications cabinet and from the MDF cabinet, as required.

### **C.3.3 Information Transmission Capacity**

The fiber optic cable is assumed to be within the allowable attenuation per kilometer as specified in TIA/EIA-568-B.1 section 11.3.3.4. The Owner’s Quality Assurance Team shall presume the transmission capacity of the cable is within specification.

### **C.4 Data Reporting and Accuracy**

The Owner’s Quality Assurance Team shall report loss measurement results, with locations and wavelength identifications, to the Owner in accordance with EIA/TIA OFSTP-14 and OFSTP-

## **Figure C - Testing Methods A, B and Adaptive B**

1. Diagrams and Explanations for testing

### **C.5 Fiber Optic Cable Installation Test Forms**

The following pages provide the two fiber optic cable installation test forms:

1. Fiber Optic Cable Installation Test Form—OTDR
2. Fiber Optic Cable Installation Test Form—Power Meter and Light Source

## **Figure C - Method A, Method B and Adapted Method B Explained Solution**

The testing of premises fiber optic cabling links requires precise methods for referencing to obtain accurate and valid test results. Loss testing for multimode fiber cabling is specified in ANSI/TIA/EIA-526-14A. This standard contains two test procedures: Method A and Method B. This article describes Methods A and B, and explains why Method B is the proper method for testing fiber links contained in premises networks.

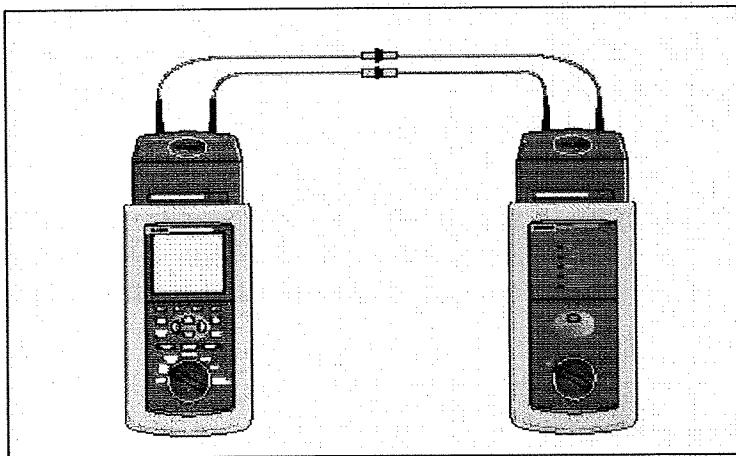
This article also proposes a new test procedure as an adaptation to Method B to overcome some disadvantages associated with Method B. This new test procedure is the preferred method because it provides results conforming to Method B while offering installers more flexibility for testing fiber links with types of connectors, including Small Form Factor (SFF) connectors. This article also details other

## *LAUSD Quality Assurance Guidelines*

advantages of the Method B adaptation for simplifying the testing process and reducing the opportunity for errors.

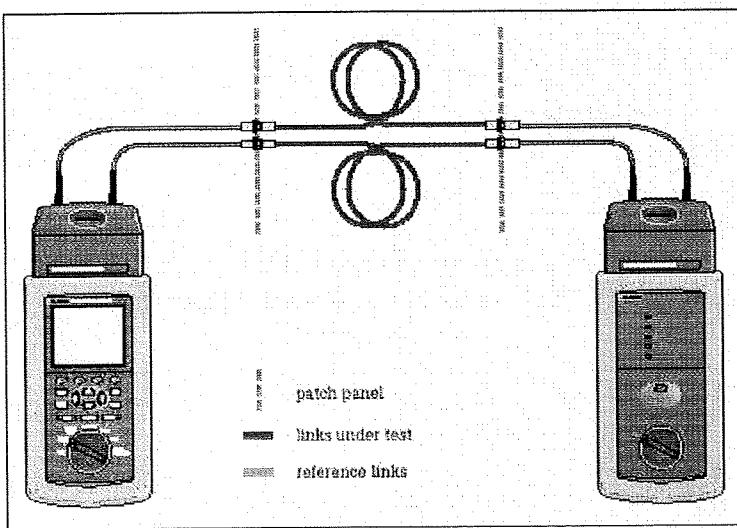
### **Method A**

Method A is used for testing links in which the total attenuation is dominated by the loss in the fiber cable, rather than the loss of the connectors, as is often the case for telecom networks. The referencing procedure for Method A uses two patch cords and an adapter connector per fiber link to be tested (See Figure 1).



**Figure 1 - Reference Configuration with a Dual Fiber Tester Simultaneously Testing Two Fiber Links**

The two patch cords and one adapter connection are referenced out when the test is performed. Therefore, the test results include the loss of the fiber link under test plus only one connection (Note the blue section in Figure 2).



## ***LAUSD Quality Assurance Guidelines***

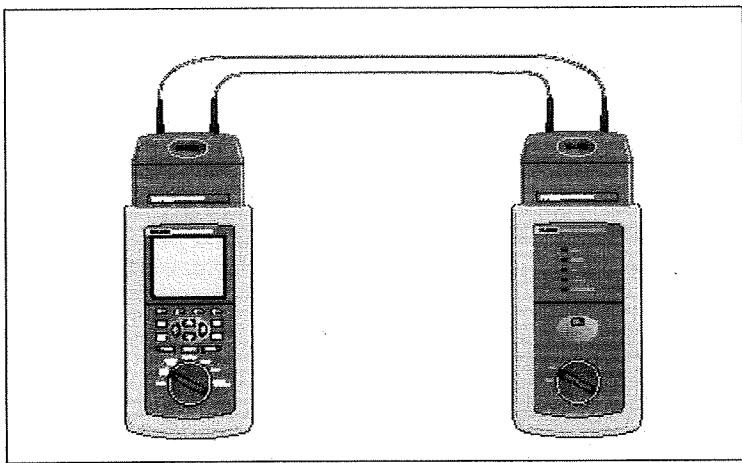
**Figure 2 - Test Configuration with Dual Fiber Tester**

While this method has been used effectively in the testing of long haul telecom fiber links, it is less precise than what is necessary for the premises market today. Because the network operation actually sees the loss of the fiber link plus the connections at both ends, Method A understates the power loss in the link since it includes only one connection. For long-haul telecom links, this is not an issue since the majority of the loss is in the long lengths of fiber with minimal loss in the precision connectors.

However, in premises applications, fiber lengths are very short and the amount of loss in the fiber cable itself is minimal. The majority of power loss is found in the connections at either end. The increasingly stringent power loss budgets of applications like Gigabit Ethernet require that the entire link loss be measured. That is where Method B becomes applicable.

### **Method B**

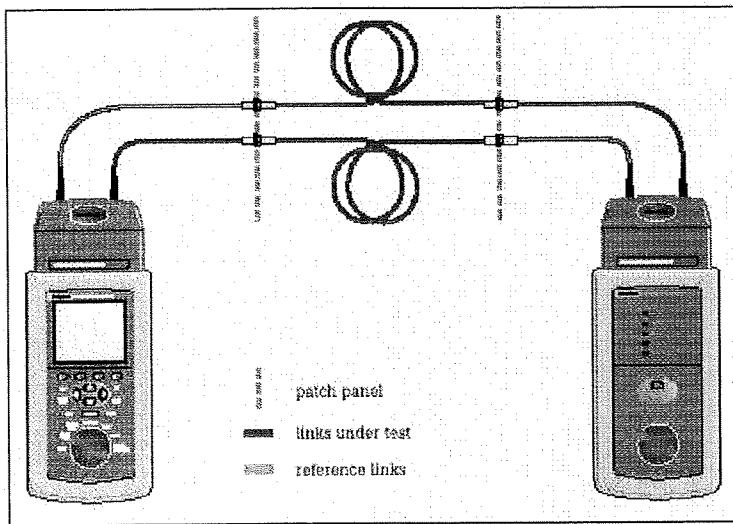
Method B is used for testing links for which the connector loss is a significant portion of the total attenuation. This is the case for premises links. The referencing procedure for Method B uses one patch cord per fiber link to be tested (See Figure 3). (Note: This figure depicts a dual fiber tester that tests two fiber links at a time.)



**Figure 3 - Method B Reference Configuration**

Since only one patch cord (per link) is part of the reference, the test results shall include loss from the fiber cable under test plus the connections at BOTH ends (see blue section in Figure 4).

## LAUSD Quality Assurance Guidelines



**Figure 4 - Method B Test Configuration**

Technically, it shall also include any loss in the additional patch cord but this is negligible because the length is so short.

For premises fiber networks, this method provides an accurate measure of the loss in the fiber link because it includes the fiber cable plus the connections at BOTH ends. However, when using Method B, be aware of the following shortcomings:

1. When going from the reference setup to the test setup, it is necessary to disconnect one end of the patch cords from the tester. It is very important never to disturb the connection at the OUTPUT or source end. If this connection is disrupted, the reference is lost, and proceeding without re-referencing shall seriously compromise the test results. Unfortunately, one could easily disconnect the patch cord from the source (OUTPUT) end instead of from the detector (INPUT) end.
2. Although you must disconnect the patch cords from the detector (INPUT) end of the tester, extreme care is required as dirt and other elements can cause damage to the detector.
3. To test Small Form Factor (SFF) connectors that have the transmit and receive fibers in the same connector, you are forced to disconnect from the source (OUTPUT) end in violation of proper referencing and test procedures.
4. Using Method B requires that you have the same type of connector on the tester as you shall be testing in the fiber link.

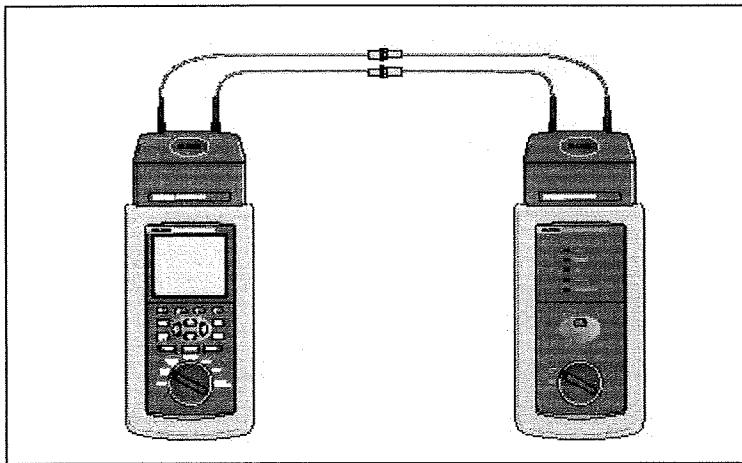
Presented in the next section is a new test procedure that is an adaptation to Method B, but provides the same test results and preserves integrity to testing Standards while overcoming the short-comings listed above.

## *LAUSD Quality Assurance Guidelines*

### **Adaptation to Method B**

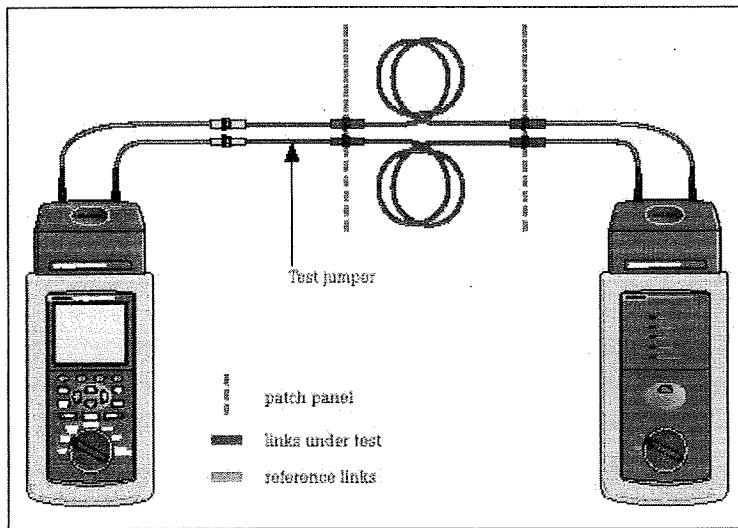
A simple adaptation to Method B allows us to retain the accuracy (every measurement includes the cable and both connections) but avoid the major disadvantages.

The referencing procedure for this adaptation is performed using 2 patch cords and an adapter connector per fiber link to be tested (See Figure 5).



**Figure 5 - Adaptation to Method B Reference Configuration**

However, the test procedure is new, and is depicted in Figure 6.



**Figure 6 - Adaptation to Method B Testing Configuration**

## *LAUSD Quality Assurance Guidelines*

The test procedure includes the addition of a short test jumper with a connector so that the test results shall now be the same as the test results obtained with Method B. Just like Method B, the results contain the loss for the fiber cable plus the connections on BOTH ends (note the blue section in Figure 6). The two patch cords and one connection per link from the reference setup have been referenced out.

### **Make the Correct Loss Measurements**

The Method B adaptation gives us several key advantages over the original Method B while preserving its accuracy:

The Method B adaptation gives loss results that conform to ANSI/TIA/EIA-526-4A, Method B. According to Method B, to measure the link loss correctly, the test path must have two more adapters in each fiber link than in the Set Reference path. The test procedure described in this article adheres precisely to this requirement. In this way, the measured loss shall be the loss of the fiber in a link plus the loss of a connection at each end of the link. This value of loss is the real value encountered by network application hardware.

The Method B adaptation allows the use of hybrid patch cables to connect test equipment to the links under test. This allows consistent testing of links with all types of connectors, including those that use small form-factor (SFF) connectors.

### **Preserve the Integrity of your Test**

The adaptation to Method B makes it unnecessary to disconnect the patch cords from the test equipment, thereby reducing the possibility of errors caused by reinsertion of patch cords or by contamination or damage of test equipment fiber interfaces.

**LAUSD Quality Assurance Guidelines**

**C.5.1 Fiber Optic Cable Installation Test Form—Omni Scanner 2 and OTDR**

Site \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_ Date \_\_\_\_\_ Q/A Review Form:  
Pass / Fail

Omni Scanner2 \_\_\_\_\_ Omni Scanner2 \_\_\_\_\_ Distant End  
Serial #: \_\_\_\_\_ Location \_\_\_\_\_ Location \_\_\_\_\_

OTDR \_\_\_\_\_ Near End TFBM \_\_\_\_\_ Distant End  
Serial #: \_\_\_\_\_ Serial #: \_\_\_\_\_ TFBM Serial #: \_\_\_\_\_

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓
850	1-blue					850	13-blue		
1300						1300			
850	2-orange					850	14-orange		
1300						1300			
850	3-green					850	15-green		
1300						1300			
850	4-brown					850	16-brown		
1300						1300			
850	5-slate					850	17-slate		
1300						1300			
850	6-white					850	18-white		
1300						1300			
850	7-red					850	19-red		
1300						1300			
850	8-black					850	20-black		
1300						1300			
850	9-yellow					850	21-yellow		
1300						1300			
850	10-violet					850	22-violet		
1300						1300			
850	11-rose					850	23-rose		
1300						1300			

**LAUSD Quality Assurance Guidelines**

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓
850	12-aqua					850	24-aqua		
1300						1300			

**C.5.2 Fiber Optic Cable Installation Test Form—Power Meter and Light Source**

Site \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_ Date \_\_\_\_\_ Q/A Review Form:  
Pass / Fail

Power Meter  
Serial #: \_\_\_\_\_ Power Meter Location \_\_\_\_\_

Light Source  
Serial #: \_\_\_\_\_ Light Source Location \_\_\_\_\_

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments
1310	1-blue					1310	13-blue				
1550						1550					
1310	2-orange					1310	14-orange				
1550						1550					
1310	3-green					1310	15-green				
1550						1550					
1310	4-brown					1310	16-brown				
1550						1550					
1310	5-slate					1310	17-slate				
1550						1550					
1310	6-white					1310	18-white				
1550						1550					
1310	7-red					1310	19-red				

*LAUSD Quality Assurance Guidelines*

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments
1550						1550					
1310	8- black					1310	20- black				
1550						1550					
1310	9- yellow					1310	21- yellow				
1550						1550					
1310	10- violet					1310	22- violet				
1550						1550					
1310	11- rose					1310	23- rose				
1550						1550					
1310	12- aqua					1310	24- aqua				
1550						1550					

## *LAUSD Quality Assurance Guidelines*

### **APPENDIX D - NETWORK EQUIPMENT PERFORMANCE TESTS**

#### **D.1 Overview of Equipment Tests**

These equipment tests verify the operation of the network components (e.g., switches, and routers) either purchased or provided for use as part of the particular project. This plan addresses industry-standard TCP/IP tests that collectively address Network layer connectivity and IP packet path routing; it does not address network performance (i.e., total throughput capabilities) tests.

The Owner's Quality Assurance Team shall perform the following interrelated tests:

1. Spanning Tree Root Bridge identification test. Spanning tree protocol is one of the most important layer 2 protocols at work in switches. Spanning Tree ensures that no loops occur in a network by a designated root bridge. The root bridge is a central point of a spanning-tree configuration and it controls how the protocol operates. It is best practice to configure the core switch to be the root bridge. Run the following command on the core switch to identify it is set as the root bridge: Show spanning-tree summary.
2. Internet Control and Message Protocol (ICMP) Ping Test. This test verifies the Network layer for connectivity by using Ether-type frame pings to reach IP target addresses and obtain or verify four results—the target IP address, the local media access control (MAC), the number of responses, and the response time. The target IP addresses are the upstream and/or downstream gateway IP addresses based on the device's connectivity in the network. The source is the management console on the device. Each test includes two steps, if necessary, as follows:
  - a. Obtain the four results by performing an address resolution protocol (ARP) for the target IP address and verifying the ping.
  - b. If test 1 is unsuccessful, obtain the four results by executing an ARP for the default router, then use the acquired MAC address to determine the IP address, send an ICMP echo request and monitor for the ICMP reply.
3. Trace Route/Path Discover. This test determines the path IP packets follow, and reports each router encountered in the path. Testing elicits an ICMP TIME-EXCEEDED response from each router encountered. Each hop is tested three times to help identify changing routes.
4. Configuration Test. This test verifies that each new network port is operational. Perform an ICMP ping from each port not previously tested, ensuring each port has a link light indicating port operability.

## *LAUSD Quality Assurance Guidelines*

5. VLAN configuration verification. Inspect VLAN configuration and port assignments to be matching the provided documentation. Inspect VLAN trunking, and verify forwarding state of required VLANs on VLAN trunks.

### **D.2 Test Equipment**

The following test equipment shall be used:

1. Fluke 682 Enterprise LAN Meter or equivalent.
2. Computer with TCP/IP protocol stack, TELNET application and data capture software (optional).

### **D.3 Test Methodology**

The basic test methodology is to verify connectivity from user access ports through and within the installed intra-network to the WAN Router. Overall connectivity is verified by testing to and from points in the network. Site testing reflects the specific switch(s) and router(s) implemented at the site.

### **D.4 Test Hierarchy for Connectivity (Pings, Trace Routes and Telnets)**

Table D.4-1 contains the network equipment performance tests and corresponding descriptions.

**Table D.4-1. Network Equipment Performance Tests**

<b>TEST</b>	<b>TEST DESCRIPTION</b>
Ping from Wall outlet WAN or Internet location	Connect the computer into the network via the wall plate, obtain DHCP IP address and perform a ping to a known IP address or URL outside the campus network.

### **D.5 Network Equipment Configuration Verification and Performance Tests**

The Owner's Quality Assurance Team shall follow the test sequence shown. The following sample form lists tests to be performed at this site. For the set of Network Equipment Performance Test forms tailored to the individual communications cabinets, please see enclosed file Network Checklists.doc.

#### **D.5.1 Network Equipment Configuration Verification Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_

Building and Communications Cabinet Numbers \_\_\_\_\_

**LAUSD Quality Assurance Guidelines**

Device Name/IP	Type of device	Type of Configuration verified	PASS	FAIL
	Ethernet Switch	VLAN / STP/ port activation/ Trunking		
	Ethernet Switch	VLAN / STP/ port activation/ Trunking		
	Router/ L3 switch	IP Routing/ SNMP/ Access-lists		
	Router/ L3 switch	IP Routing/ SNMP/ Access-lists		

**D.5.2 Network Equipment Performance Test Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_

Building and Communications Cabinet Numbers \_\_\_\_\_

(a packet loss in excess of 1% during ping test is not acceptable and is considered a FAIL)

TEST	SOURCE ADDRESS/LOCATION	DESTINATION ADDRESS/LOCATION	PASS	FAIL
Ping from Wall outlet to WAN Router location				
Trace route from Wall outlet to WAN Router location				

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**APPENDIX E - PHYSICAL CONFIGURATION AUDIT**

**E.1 Overview of Physical Connectivity Audit**

A Physical Connectivity Audit is completed comparing the vendor supplied Equipment Inventory List (EIL) against the Cabinet Equipment Survey generated by the test team at Quality Assurance. This appendix provides the detailed audit of the physical equipment and materials installed under this expansion effort.

**E.2 Physical Connectivity Audit Quality Assurance Review lists**

The following sample form shows the general information to be documented for a standard Cabinet Equipment Survey.

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_

Building and Communications Cabinet Numbers \_\_\_\_\_

Location	Location Annotation	Number of Switches	Number / Type of UPS	Number of Fibers (MM/SM)	Number of Horiz. Copper drops	Number of Horiz. Fibers
MDF						
IDF1						
IDF2						
IDF3						
IDF4						
IDF5						
IDF6						
IDF7						
LDF1						
LDF2						
LDF3						
LDF4						
Notes:						

*LAUSD Quality Assurance Guidelines*

**APPENDIX F - CABLE DOCUMENTATION SPECIFICATION**

**F.1 Documentation.**

- F.1.1** The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
- F.1.2** Individual test reports shall be submitted in hardcopy and electronic format. Hand-written test reports are not acceptable.
- F.1.3** The test results records saved by the tester shall be transferred into a Windows™- based database utility, such as MS Access, or SQL, or MS Excel spreadsheet, that allows for the maintenance, review and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
- F.1.4** Hardcopy reports may be submitted in labeled 3 ring binders with an attached affidavit verifying passing execution of tests. For large installations electronic reports with hardcopy summaries are preferred. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, length, and date of test and pass/fail result.
- F.1.5** Electronic reports are to be submitted in CD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., then software to read these files is not needed. Electronic reports must be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
- F.1.6** Test reports shall include the test measurement information specified in Section 5 for each cabling element tested, in addition to:
- F.1.7** Cable manufacturer, cable model number/type and NVP.
- F.1.8** Tester manufacturer, model, serial number, hardware version and software Ver. 6.
- F.1.9** Circuit ID number.
- F.1.10** Auto test specification used.
- F.1.11** Identification of the tester interface.
- F.1.12** Overall pass/fail indication.
- F.1.13** Date and time of test.

Table F.2 Cable Test Parameter Preferences

### ***LAUSD Quality Assurance Guidelines***

When reading the printed test result output, the following parameters must be shown with the associated cable test.

<b>Cable Testing Parameter Preferences</b>								
<b>Cable Test</b>	<b>NVP</b>	<b>Cable</b>	<b>Auto test</b>	<b>Fiber Type</b>	<b>GRI</b>	<b>Reference</b>	<b>Test Direction</b>	<b>Pulse Width</b>
Level (II) Category 5 E Tester	69 – 72	Cat 5E	Cat 5E Perm link	n/a	n/a	n/a	n/a	n/a
Level (III) Category 6 Tester	69 – 72	Cat 6	Cat 6 Perm link	n/a	n/a	n/a	n/a	n/a
Power Meter Horizontal MM F/O @ 850nm/1300nm	n/a	62.5/125 Mnfr	568B Horizontal	Multimode 50 or 62.5	1.4920 @ 1300nm	1 jumper method	Bi-Directional	n/a
Power Meter Backbone MM F/O @ 850nm/1300nm	n/a	62.5/125 Mnfr	568B Backbone	Multimode 50 or 62.5	1.4920 @ 1300nm	1 jumper method	Bi-Directional	n/a
Power Meter Backbone SM F/O @ 1310nm/1550nm	n/a	SM Mnfr	1000 Base –LX	Single Mode	1.4640 @1300nm	1 jumper method	Bi-Directional	n/a
OTDR Horizontal MM F/O @ 850nm/1300nm	n/a	n/a	n/a	Single Mode	n/a	n/a	Uni-Directional	<50ns
OTDR Backbone MM F/O @ 850nm/1300nm	n/a	n/a	n/a	Single Mode	n/a	n/a	Uni-Directional	<50ns
OTDR Backbone SM F/O @ 1310nm/1550nm	n/a	n/a	n/a	Single Mode	n/a	n/a	Uni-Directional	<50ns

NOTE: The length of the cable is the variable of which the Power Meter and light source determines the expected dB loss for Backbone cable tests.

Table F.3 Allowable Distance per Fiber Length

*LAUSD Quality Assurance Guidelines*

Use this table as a guideline to compare references for dB loss in the installed Backbone Fiber. Total loss includes .75 dB loss per mated connector pair.

Fiber Cable Distance	Multimode dB Loss	Singlemode dB Loss	Fiber Cable Distance	Multimode dB Loss	Singlemode dB Loss
100'	1.6	1.53	1200'	2.7	1.86
200'	1.7	1.56	1300'	2.8	1.89
300'	1.8	1.59	1400'	2.9	1.92
400'	1.9	1.62	1500'	3.0	1.95
500'	2.0	1.65	1600'	3.1	1.98
600'	2.1	1.68	1700'	3.2	2.01
700'	2.2	1.71	1800'	3.3	2.04
800'	2.3	1.74	1900'	3.4	2.07
900'	2.4	1.77	2000'	3.5	2.10
1000'	2.5	1.80	2100'	3.6	2.13
1100'	2.6	1.83	2200'	3.7	2.16

**SECTION 26 0500**  
**COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 01.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 03 3000 - Cast-in-Place Concrete.
  - 3. Section 09 9000 - Painting and Coating.
  - 4. Division 14 - Conveying Equipment.
  - 5. Division 23 - HVAC.
  - 6. Division 27 – Communications.
  - 7. Division 28 - Electronic Safety and Security.
  - 8. Section 31 2323 - Excavation and Fill for Utilities.
- C. Applicable Standards
  - 1. ASTM D 709 (2007) – Laminated Thermosetting materials.
  - 2. ANSI/NEMA FB-1 (2010) – Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
  - 3. ANSI/NEMA 250 (2008) – Enclosure for Electrical Equipment (1000 Volts Maximum).
  - 4. California Electrical Code (CEC).
  - 5. IEEE C57.12.28 (2005) – Standard for Pad-Mounted equipment (Enclosure Integrity).
  - 6. UL 1 (2005) – Standard for Flexible Metal Conduit.

7. UL 1242 (2007) – Standard for Electrical Intermediate Metal Conduit.
8. UL 506 (2008) – Specialty Transformers.
9. UL 6 (2010) – Electrical Rigid Metal Conduit-Steel.
10. UL 797 (2007) – Electrical Metallic Tubing-Steel.
11. UL 870 (2008) – Standard for Wireways, Auxiliary Gutters, and Associated Fittings

## 1.02 BASIC ELECTRICAL REQUIREMENTS

### A. Quality Assurance:

1. Workers possessing the skills and experience obtained in performing work of similar scope and complexity shall perform the Work of this Division.
2. Refer to other sections of the Specifications for other qualification requirements.

### B. Drawings and Specifications Coordination:

1. For purposes of clearness and legibility, Drawings are essentially diagrammatic and the size and location of equipment is indicated to scale whenever possible. Verify conditions, dimensions, indicated equipment sizes, and manufacturer's data and information as necessary to install the Work of this Division. Coordinate location and layout with other Work.
2. Verify final locations for rough-ins with field measurements and with the requirements of the equipment to be connected.
3. Drawings indicate required size and points of termination of conduits, number and size of conductors, and diagrammatic routing of conduit. Install conduits with minimum number of bends to conform to structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and comply with applicable code requirements.
4. Routing of conduits may be changed provided that the length of any conduit run is not increased more than 10 percent of length indicated on the Drawings.
5. Outlet locations shall be coordinated with architectural elements prior to start of construction. Locations indicated on the Drawings may be distorted for clarity.
6. Coordinate electrical equipment and materials installation with building components and the Work of other trades

7. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
8. Coordinate connection of electrical systems with existing underground utilities and services.

C. Terminology:

1. Signal Systems: Applies to clock, bell, fire alarm, annunciator, sound, public address, buzzer, telephone, television, inter-communication, elevator access controls, lighting control systems and security systems.
2. Low Voltage: Applies to signal systems operating at 120 volts and less, and power systems operating at less than 600 volts. Medium voltage: Applies to power systems operating at more than 600 volts.
3. UL: Underwriter's Laboratories Inc, Nationally Recognized Testing Laboratory (NRTL), or equal.

D. Regulations: Work shall comply with the requirements of authorities having jurisdiction and the California Electrical and Building Codes. Material shall conform to regulations of the National Board of Fire Underwriters for electrical wiring and apparatus. Materials shall be new and listed by UL, or another NRTL.

E. Structural Considerations for Conduit Routing:

1. Where conduits pass through or interfere with any structural member, or where notching, boring or cutting of the structure is necessary, or where special openings are required through walls, floors, footings, or other buildings elements, conform to CBC, Part 2, Title 24, Section 1906.3 for conduits and pipes embedded in concrete and Sections 2308.9.10 and 2308.9.11 for notches and bored holes in wood; for steel, as detailed on the structural steel Shop Drawings.
2. Where a concrete encasement for underground conduit abuts a foundation wall or underground structure which the conduits enter, encasement shall rest on a haunch integral with wall or structure, or shall extend down to footing projection, if any, or shall be doweled into structure unless otherwise indicated. Underground structures shall include maintenance holes; pull boxes, vaults, and buildings.
3. Holes required for conduit entrances into speaker poles, floodlight poles or other poles, shall be drilled with the conduit nipple or coupling welded to poles. Welds shall be provided by the electric arc process and shall be continuous around nipple or coupling.

F. Electrically Operated Equipment and Appliances:

1. Furnished Equipment and Appliances:

- a. Work shall include furnishing and installing wiring enclosures for, and the complete connection of electrically operated equipment and appliances and electrical control devices which are specified to be furnished and installed in this or other sections of the Specifications, wiring enclosures shall be concealed except where exposed Work is indicated on the Drawings.
- b. Connections shall be provided as necessary to install equipment ready for use. Equipment shall be tested for proper operation and, if motorized, for proper rotation. If outlets are of incorrect electrical characteristics or any specified equipment fails to operate properly, repair and/or replace the outlet and/or equipment.

2. Equipment and Appliances Furnished by Others:

- a. Equipment and appliances indicated on Drawings as "not in contract" (NIC), "furnished by others," or "furnished by the Owner," will be delivered to the Project site. Required electrical connections shall be performed for such equipment and appliances. Motorized equipment will be furnished factory-wired to a control panel or junction box unless otherwise indicated. Appliances will be furnished equipped with portable cord and cap. Provide disconnect switches where required.
- b. Connections to equipment furnished under this Division shall be part of the Work of this section. Work shall include internal wiring, installation, connection and adjustment of bolted drive motors in which the motor is supplied as a separate unit, and connections only for equipment furnished with factory installed internal wiring, except as further limited by Drawings and this Specification. Work shall include furnishing and installing suitable outlets, disconnecting devices, starters, push-button stations, selector switches, conduit, junction boxes, and wiring necessary for a complete electrical installation. Work shall also include furnishing and installing conduit and boxes for HVAC control systems, furnished under Division 23. Devices and equipment furnished shall be of same type used elsewhere on the Work or as specified.
- c. Electrical equipment furnished under other sections, for installation and connection under Work of this section, will be delivered to the Project site ready for installation.
- d. Mechanical equipment furnished under other sections, and requiring electrical connection under this section, will be set in place as part of the Work of the section furnishing such equipment unless noted otherwise.

- e. Suitability and condition of equipment furnished under other sections shall be determined in advance of installation. Immediate notice of damage, unsuitability, or lack of parts shall be given to the entity providing such equipment.

**G. Protection of Materials:**

1. Protect materials and equipment from damage and provide adequate and proper storage facilities during progress of the Work. Damaged materials and/or equipment shall be replaced.

**H. Cleaning:**

1. Exposed parts of Work shall be left in a neat, clean, usable condition. Finished painted surfaces shall be unblemished and metal surfaces shall be polished.
2. Thoroughly clean parts of apparatus and equipment. Exposed parts to be painted shall be thoroughly cleaned of cement, plaster, and other materials. Remove grease and oil spots with solvent. Such surfaces shall be wiped and corners and cracks scraped out. Exposed rough metal shall be smooth, free of sharp edges, carefully steel brushed to remove rust and other spots, and left in proper condition to receive finish painting.
3. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**I. WARRANTIES**

1. Provide one year warranty on all material and labor performed, unless noted otherwise in specific sections.

**PART 2 - PRODUCTS - NOT USED**

**PART 3 - EXECUTION**

**3.01 GENERAL REQUIREMENTS**

- A. Advise the Inspector before starting the Work of this Division.
- B. Exposed conduits shall be painted to match the surfaces adjacent to installation.
- C. Salvaged materials removed from buildings shall be removed from the Project site as required by the OAR.

- D. Trenches outside of barricade limits shall be backfilled and paved within 24 hours after being inspected by the Inspector. Provide traffic plates during the time that trenches are open in traffic areas and in areas accessible to students and staff.
- E. Where existing structural walls are cored for new conduit runs, separation between cored holes shall be three inches edge to edge from new or existing holes, unless otherwise required by the Architect. All coring to be laid out and reviewed by Architect prior to drilling. Contractor to verify location of structural steel, rebar, stress cabling or similar prior to lay out.
- F. Electrical equipment shall be braced and anchored for CBC Seismic Design requirements, or as otherwise indicated on the Drawings.

### 3.02 DELIVERY STORAGE AND HANDLING

- A. Deliver products to project site with proper identification, which shall include names, model numbers, types, grades, compliance labels, and similar information needed for District identification; all products and materials shall be adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion.

### 3.03 CUTTING AND PATCHING

- A. Cutting and patching of electrical equipment, components, and materials shall include the removal and legal disposal of selected materials, components, and equipment.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- C. Repair or restore other work, or surfaces damaged as a result of the work performed under this contract.

### 3.04 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose off the Project site.
- B. Remove equipment and implements of service, and leave entire work area neat and clean, to the satisfaction of the Owner Authorized Representative.

### 3.05 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

**SECTION 26 0513**  
**BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Boxes, enclosures, keys and locks.
2. Receptacles and switches.
3. Identifications and signs.

**B. Related Requirements:**

1. Division 01 - General Requirements.
2. Division 26 – Electrical.
3. Division 27 – Communications.
4. Division 28 - Electronic Safety and Security.

**PART 2 - PRODUCTS**

**2.01 BOXES, ENCLOSURES, KEYS AND LOCKS**

**A. Outlet Boxes and Fittings:**

1. Outlet boxes installed in concealed Work shall be galvanized steel, pressed, or welded type, with knockouts.
2. In exposed Work, where conduit runs change direction or size, outlet boxes and conduit fittings shall be cast metal with threaded hubs cast integral with box or fitting.
3. Fittings shall be cast metal and non-corrosive. Ferrous metal fittings shall be cadmium-plated or zinc galvanized. Castings shall be true to pattern, smooth, straight, with even edges and corners, of uniform thickness of metal, and shall be free of cracks, gas holes, flaws, excessive shrinkage, and burnt-out sand.
4. Covers for fittings shall be galvanized steel or non-corrosive aluminum and shall be designed for particular fitting installed.

5. For local device outlets provide 4-inch square 2 1/8-inch deep, boxes for single gang, 5-inch square boxes for two-gang, and special solid gang boxes with gang plaster ring for more than two switches.
  6. For TV outlets, and horns and strobes provide manufacturer's supplied back box as needed. For television outlets, provide 4-gang deep boxes and 4-gang plaster rings.
  7. Plaster rings shall be provided on flush-mounted outlet boxes except where otherwise indicated or specified. Plaster rings shall be same depth as finished surface. Install approved ring extension to obtain depth to finish surface.
  8. In existing plywood wall or drywall construction, and where flexible steel conduit is fished into walls, single-gang and 2-gang outlets for wiring devices may be sectional steel boxes with plaster ears. Boxes shall be fastened to plywood with flat-head screws in each plaster ear screw hole. Boxes fastened to gypsum board shall be Raco, Appleton, Cooper, Bowers, or equal.
  9. Factory made knockout seals shall be installed to seal box knockouts, which are not intact.
  10. Where flexible conduit is extended from flush outlet boxes, provide and install weatherproof universal box extension adapters.
- B. Junction and Pull boxes:
1. Junction and pull boxes, in addition to those indicated, shall only be used in compliance with codes, recognized standards, and Contract Documents.
  2. Interior and non-weatherproof boxes shall be constructed of blue or galvanized steel with ample laps, spot welded, and shall be rigid under torsion and deflecting forces. Boxes shall be furnished with auxiliary angle iron framing where necessary to ensure rigidity.
  3. Covers shall be fastened to box with a sufficient number of machine screws to ensure continuous contact all around. Flush type boxes shall be drilled and tapped for cover screws if boxes are not installed plumb. Surfaces of pull and junction boxes and covers shall be labeled in black marker ink designating system, panelboard and circuit designation contained in box. In exposed Work, designation shall be installed on inside of pullbox or junction box cover.
  4. Weatherproof NEMA 3R pull and junction boxes shall conform to foregoing for interior boxes with following modifications:
    - a. Cover of flush mounting boxes shall be furnished with a weather-tight gasket cemented to, and trimmed even with, cover all around.
    - b. Surface or semi-flush mounting pull and junction boxes shall be UL, or another Nationally Recognized Testing Laboratory (NRTL) listed as rain-tight and shall be furnished complete with threaded conduit hubs.

- c. Exposed portions of boxes shall be galvanized and finished with one prime coat and one coat of baked-on gray enamel, unless already furnished with factory baked-on finish.
- 5. Junction and pull boxes shall be rigidly fastened to structure and shall not depend on conduits for support.
- 6. Underground Concrete Pull Boxes:
  - a. Pre-cast concrete pull boxes. Concrete pull boxes shall be traffic type, reinforced for H-20 wheel loading, pre-cast concrete. Pull boxes with inside dimensions of 2 feet by 3 feet by 3 feet deep shall consist of a base section, top ring, and cover. Base section shall be furnished with 2 knockouts measuring 10 inch by 10 inch in each 3 feet side, and one 20 inch by 20 inch knockout in each 2-foot side. Pull boxes with inside dimension 4 feet by 4 feet by 4 feet deep shall consist of a base section, midsection, topping, and cover. Base section shall be furnished with 2 knockouts measuring 8-inch by 16-inch on each of two opposite sides, and one 20-inch by 20-inch knockout on each of other two opposite sides. Pull boxes shall be furnished with a minimum of 6-inch diameter sump knockout and one inch diameter ground rod knockout. In pull boxes, furnish and install cable racks on walls. Racks shall be furnished with 3 porcelain cable holders on vertical steel mounting bars. Pull boxes shall be furnished with 3/4 inch diameter pull irons. Covers shall be traffic-type consisting of steel safety plate bolted to frame. Covers shall be marked as electrical, power, or signal as required. Pull boxes shall be as manufactured by Oldcastle Precast, Jensen Precast, Kistner, Western Precast, or equal.
  - b. Provide end bells in duct entrances. Terminate each metal conduit with insulated bushing provided with a grounding terminal.
  - c. Install pulling irons on opposite walls and below horizontal centerlines of ducts and bricked-up openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.
  - d. Remove floor drain knockout and provide a depth of 24 inches of crushed rock below box extending a minimum of 12 inches beyond on all sides.
  - e. Permanently and effectively ground metal equipment cases, cable racks, and similar items in pull boxes to site grounding electrode system. Provide grounding conductor in compliance with CEC Article 250.
  - f. Provide 6-inch deep sand base under pull boxes.
  - g. Identify power and signal cables by tagging in manholes and pull boxes. Tie securely to cables with nylon cord.
  - h. Top of steel plate shall provide a minimum coefficient of static friction of 0.5 for either wet or dry locations, when tested for any shoe sole material. Test shall comply with ASTM D 1047 or F 489 or F 609 standards.

10/01/2011

Submit manufacturer's test results for Architect's review as part of materials and equipment submittals.

- i. The use of underground extension boxes shall be limited to not more than 1 times the original depth of pull box.
- 7. Underground utility boxes shall be reinforced concrete with non-setting shoulders to prevent settlement following installation. Boxes shall be furnished with cast iron cover with finger hole, size as indicated on Drawings. Utility boxes shall be as manufactured by Oldcastle, Jensen, Kistner, Western Precast, or equal.
- 8. Manholes, vaults, and pull boxes required by a utility company, and installed as part of this Contract, shall meet requirements of servicing utility company.

C. Keys and Locks:

- 1. Provide two keys with furnished door locks, including cabinet door locks and switchboard locks, two keys for lock switches on switchboards or control panels, and two keys with interlocks or other furnished lock switches. Deliver keys to OAR.
- 2. Locks shall be keyed to Corbin No. 60 keys for access to operate equipment and Corbin 70 keys for service access. Special keys and locks shall only be provided where specified.

## 2.02 RECEPTACLES AND SWITCHES

A. Receptacles:

- 1. Duplex receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wired with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be PVC. Receptacle face shall be ivory, impact resistant nylon. Receptacles shall have triple wipe brass power contacts.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
(20 amps) NEMA 5-20	PS5362-I	HBL5362-I	5362-I
(15 amps) NEMA 5-15	PS5262-I	HBL5262-I	5262-I

- 2. Duplex receptacles on circuits supplied by panel boards with integral surge suppression shall be Pass & Seymour model number PS5262BL (blue), Hubbell DRUBTVSS15, Leviton 5262-SBU, 15 amps, 120 volts, or equal.
- 3. Single receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wire with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be thermoplastic. Receptacle face shall be ivory, impact resistant nylon. Receptacles shall have triple wipe brass power contacts. For circuits consisting of one single receptacle only, ampere rating of receptacle shall be same as circuit breaker or fuse.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
(20 amps) NEMA 5-20R	5361-I	HBL5361-I	5361-I

10/01/2011

(15 amps) NEMA 5-15R      5261-I      HBL5261-I      5261-I

4. 15 and 20 amps single receptacles on circuits supplied by panel boards with integral surge suppression shall be Pass & Seymour NEMA 5-20R model number 5361-BL (blue), and NEMA 5-15R model number 5261-BL (blue) respectively. Equal receptacles by other Owner approved manufactures are acceptable.
5. Provide specification grade ground-fault circuit interrupter (GFCI) type receptacles in accordance with 2010 UL standards. GFCI receptacles shall have a trip indication light. Receptacle terminal screws shall be back and side wire with internal screw pressure plates. Test and reset buttons shall match device body and shall be ivory. GFCI receptacles shall be manufactured in standard configuration for installation with stainless steel smooth plates. Exterior mounted receptacles shall be mounted inside weatherproof enclosure.

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 5-20R	2095-I	GFR5352-IA	7899-I
NEMA 5-15R	1595-I	GFR5252-IA	8598-I

6. Provide weatherproof receptacles, except where otherwise indicated or specified, consisting of GFCI receptacles, as specified herein, and metal plates with die-cast lockable hinged lids and weatherproof mats;

#### B. Switches:

##### 1. Local Switches:

- a. Provide local switches, high strength thermoplastic toggle, specification industrial grade, rated 20 amps at 120-277 volts AC only, with plaster ears, external screw pressure plate back and side wired, and standard size composition cups which fully enclose mechanism. Switches shall be approved for installation at currents up to full rating on resistive, inductive, tungsten filament lamp and fluorescent lamp loads, and for up to 80 percent of rating for motor loads. Switches shall have oversized silver alloy contacts for long life and better heat dissipation. Provide switches as single pole, double pole, 3-way, 4-way, non-lock type. Provide non-lock type switches with ivory handles;

	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
Single pole	PS20AC1I	HBL1221I	1221-2I
Double pole	PS20AC2I	HBL1222I	1222-2I
Three way	PS20AC3I	HBL1223I	1223-2I
Four way	PS20AC4I	HBL1224I	1224-2I

- b. Provide lock type switches, specification industrial grade, 20 amp, 120-277 volts with metal or nylon key guides with on/off indication, and operable by same key. Key shall be District standardized vertically oriented, tamper resistant, forked key with two each 5/16-inch long forks, 5/32-inch spacing between forks and 5/16-inch width overall.

	<u>Pass &amp; Seymour</u>	<u>Arrow Hart</u>
Single pole	PS20AC1L w/#500 Key-2L	1221L w/1201LK Key
Double pole	PS20AC2Lw/#500 Key	1222L w/1201LK Key

10/01/2011

Three way Four Way	PS20AC3L w/#500 Key PS20AC4L w/#500 Key	1223L w/1201LK Key 1224L w/1201LK Key
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## 2.03 IDENTIFICATION AND SIGNS

### A. Identification Plates:

1. Provide identification plates for the following unless otherwise specified, for switchboards, unit substations, motor control centers, control panels, push-button stations, time switches, contactors, motor starters, motor switches, panelboards, and terminal cabinets.
2. Identification plates shall be of plastic stock and shall adequately describe function, voltage and phase of identified equipment. Where identification plates are detailed or described on Drawings, inscription and size of letters shall be as indicated. For lighting and power panels, identification plates shall indicate panel designation, voltage, and phase of panel. For terminal cabinets, identification plates shall indicate system contained in terminal cabinet.
3. Identification plates shall be black-and-white nameplate stock of bakelite with characters cut through black exposing white. Plates shall be furnished with beveled edges and shall be securely fastened in place with No. 4 Phillips-head, cadmium-plated steel, self-tapping screws. Characters shall be 3/16 inch high, unless otherwise indicated.

### B. Markings:

1. Install identification markings to surface-mounted starters, switches, disconnect switches, contactors, and other devices controlling motors and appliances. Provide abbreviations required along with an identifying number. Markings to be provided with locking type stencils using paint of a contrasting color. Figures shall be 3/8 inch high unless otherwise indicated. Dymo Industries Inc., self-sticking plastic labels, with embossed characters made with a typewriter may be installed instead of stencils and paint; p-touch self adhesive plastic, or Brother P-Touch self sticking laminated plastic labels may be installed.

### C. Warning Signs:

1. Provide a warning sign on outside of each door or gate to rooms or enclosures containing high voltage equipment. Signs required reading, "WARNING - HIGH VOLTAGE - KEEP OUT". Provide 2-inch high lettering.
2. Provide a warning sign on each high-voltage non-load break disconnect and fused cutout (not oil filled). Signs required reading, "DO NOT OPEN UNDER LOAD". Provide 2 inch high lettering.

3. Provide signs of standard manufacture, 18 gage steel, with porcelain enamel finish. Provide red lettering on a white background.

## PART 3 - EXECUTION

### 3.01 INSTALLATION AND SUPPORT OF BOXES

- A. Install outlet boxes flush with finished surface of wall or ceiling. Install plumb and securely fastened to structure, independent of conduit. Except where otherwise indicated, provide factory-fabricated adjustable attachment bar hangers between studs to support outlet boxes. When installation is performed in fire rated walls, maintain the wall's rating integrity by means of approved fire stop methods.
- B. Outlet boxes installed in suspended or furred ceilings with steel runner or furring channels shall be supported, except where otherwise indicated, by a Unistrut P-4000 Tessco A1200HS-10, Cooper B-Line B22s-HG, or equal channel spanning main ceiling runner channels. Each box shall be supported from its channel by a 3/8 inch 16 threaded steel rod with a Unistrut P-4008, Fastenal #48604, Copper B-Line 78101140346 or equal nut and a Tomic No. 711-B Adapta-Stud, or equal. Rod shall be tightened to a jamb fit with channel and its nut. Box shall be locked to rod by means of a 1/2 inch locknut on stud and a 3/8 inch 16 hex nut locking stud to rod.
- C. Heights of outlets and equipment indicated on Drawings shall govern. In absence of such indications, following heights shall be maintained with heights measured to centerline unless otherwise noted:
  1. Install wall-mounted telephones, light switches, and other switches, 48 inches above finished floor. Refer to other Division 26, 27 and 28 Sections.
  2. Outlet boxes for fire alarm pull stations shall be mounted at 45 inches above finished floor to insure that the operating handle of the initiating device is no higher than 48 inches at finished floor. Under no circumstances shall operating handle of the device exceed 48 inches above finished floor regardless of indicated height on drawing.
  3. Wall mounted fire alarm strobe or horn/strobe devices shall be mounted such that the entire lens is not less than 80 inches above finished floor. If ceiling heights allow, wall mounted appliances shall have bottom of lens a minimum of 80 inches but not more than 96 inches to the top of lens.
  4. Install outdoor fire alarm audible devices or fire alarm sprinkler flow bells at least 10 feet but not more than 12 feet above finished floor to center. Provide STI or equal protective covers for devices when required.
  5. Voice evacuation speakers mounted indoors shall be mounted in ceiling space or if mounted on wall shall not be less than 10 feet to center above finished floor.
  6. Install clocks and speakers, in classrooms and offices, 8 feet above finished floor. Unless otherwise indicated.

7. In rooms other than places of assembly such as, but not limited to, multipurpose rooms, auditoriums, and libraries, clock outlets and speakers in classrooms and offices shall be mounted 8 feet above finished floors. Other assembly areas such as gymnasiums shall be mounted 10 to 12 feet above finished floor. Provide STI, or equal protective covers for clocks when required.
8. Install fire alarm strobe lights 80 inches to bottom of light above finished floor.
9. Install outside bells and yard light outlets 4 feet above second floor level for 2 or more story buildings, 12 inches below top plate level for one story buildings without covered porch or arcade, and 12 inches below covered porch and arcade ceilings.
10. Install desk telephones, power receptacle outlets, and data outlets 15 inches above finished floor.
11. Install panelboards and terminal cabinets 6 feet 6 inches from finish floor to top of cabinet.
12. Install television outlets at a height corresponding to location of television monitor, or a minimum of 15 inches above finished floor.
13. The use of extension boxes shall be limited to not more than 1 times the original depth of junction box.

### 3.02 COVER PLATES

- A. Provide a plate on each switch, plug, pilot light, data, interphone, public telephone, and television outlet, and on existing and reset outlets where so indicated or required. Plates shall be of stainless steel unless otherwise specified.
- B. Flush wiring device and signal system outlets indicated to be blank covered, shall be covered with blank stainless steel plates. Flush lighting outlets to be blanked shall be covered with Wiremold 5736 steel covers, or equal, painted to match surrounding finish. Provide stainless steel covers to blank indicated or required surface-mounted outlets.
- C. In the following cases, and at required locations. Switch and receptacle plates shall be engraved with the device(s), or fixtures being controlled, or as indicated:
  1. Three-gang and larger gang switches in locations other than classrooms.
  2. Lock switches.
  3. Pilot switches.
  4. Switches so located that operator cannot see fixtures, or items of equipment controlled while his hand is on the switch.
  5. Switches not in same room with fixtures or items of unit heaters, air curtains, fly fans, etcetera.

- 6. Receptacles operating at other than 120 V shall be identified with the operating voltage.
- 7. Switches operating on 277 V shall be identified with the operating voltage.
- 8. Where indicated on Drawings.

- D. Designations shall be as indicated on Drawings or as specified by Architect.
- E. Standard GFI cover plates shall be Pass & Seymour 4600, Raco 5028-0, or equal. GFI cover plates shall be provided with a CAM lock mechanism with two keys or a padlock hasp that does not protrude through the face of the cover and will allow the shank of locks keyed Corbin No. 60 keys.

### 3.03 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

- A. Provide descriptive nameplates or tags permanently attached to switchboards, motor control centers, transformers, panelboards, circuit breakers, disconnect switches, starters, pushbutton control stations and other apparatus installed for operation or control of circuits, appliances, fire alarm control panel(s), fire alarm annunciator(s), power supplies, terminal cabinets, energy management control units, and Information technology system backbone and distribution equipment points.
- B. Provide nameplates of engraved laminated plastic, or etched metal. Submit Shop Drawings denoting dimensions and format to Architect before installation. Fasten to equipment with escutcheon pins, rivets, self-tapping screws, or machine screws. Self-adhering or adhesive backed nameplates are not permitted.
- C. Fasten tags to feeder wiring in conduits at every point where runs are broken or terminated, including pull wires in empty conduits. Indicate circuit, phase, and function. Tag branch circuits in panel boards and motor control centers. Tags may be manufactured of pressure-sensitive plastic or embossed self-attached stainless steel or brass ribbon.
- D. Provide circuit identification cards and cardholders in all panel boards. Cardholders shall consist of metal frame retaining a clear plastic cover permanently attached to inside of panel door. List of circuits shall be typewritten on a card. Circuit description shall include name or number of circuit, area and connected load.
- E. Junction and pull boxes shall have covers stenciled with box number when indicated on Drawings, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting with finish.
- F. Name shall be correctly engraved, with a legend indicating function or areas, when required by codes or indicated on Drawings.

### 3.04 PROTECTION

- A. Protect Work of this section until Substantial Completion.

### 3.05 CLEANUP

10/01/2011

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- A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION

**SECTION 26 0519**  
**LOW-VOLTAGE WIRES (600 VOLT AC)**

**PART 1 - GENERAL****1.01 SUMMARY**

- A. Provisions of Division 01 apply to this section.
- B. Section Includes: Low-voltage wire, splices, terminations and installation.

**1.02 SUBMITTALS**

- A. Provide in accordance with Division 01.

**PART 2 - PRODUCTS****2.01 WIRES**

- A. Wires shall be single conductor type THHN or THWN insulated with polyvinyl chloride and covered with a protective sheath of nylon, rated at 600 volts. Wires may be operated at 90 degrees C. maximum continuous conductor temperature in dry locations, and 75 degrees C. in wet locations and shall be listed by UL Standard 83 for thermoplastic insulated wires, listed by Underwriter's Laboratories (UL) for installation in accordance with Article 310 of the California Electrical Code (CEC). Conductors shall be solid copper for 12 AWG and smaller conductors, and stranded copper for 10 AWG and larger conductors. Conductors shall be insulated with PVC and sheathed with nylon. Wires shall be identified by surface markings indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol, type designations and optional rating. Indentations for lettering are not permitted. Wires shall be tested in accordance with the requirements of UL standard for types THWN, or THHN.
- B. Conductors shall be solid Class B or stranded Class C, annealed uncoated copper in accordance with UL standards, or another Nationally Recognized Testing Laboratory (NRTL).

**2.02 STANDARDS**

- A. THWN/THHN wires shall comply with the following standards:
  1. UL 83 for thermoplastic insulated wires.
  2. UL 1063 for machine tool wires and cables.

**PART 3 - EXECUTION****3.01        INSTALLATION**

- A. Wires shall not be installed until debris and moisture is removed from conduits, boxes, and cabinets. Wires stored at site shall be protected from physical damage until they are installed and walls are completed.
- B. Wire-pulling compounds furnished as lubricants for installation of conductors in raceways shall be compounds approved and listed by UL, NRTL, or equal. Oil, grease, graphite, or similar substances are not permitted. Pulling of 2 AWG or larger conductors shall be performed with a cable pull machine. Any runs shorter than 50 feet are exempt. When pulling conductors, do not exceed manufacturer's recommended values
- C. The Project Inspector will observe installation of feeder cables. Notify the Project Inspector not less than two working days in advance of the proposed time of feeder installation.
- D. At outlets for light, power, and signal equipment, pigtail splices with 8-inch circuit conductor leads for connection to fixtures, equipment, and devices.
- E. Pressure cable connectors, pre-insulated 3M Scotchlok, Hubbell Power, O-Z/Gedney or equal, Y, R or B spring-loaded twist-on type, may be furnished in splicing number 8 AWG or smaller wires for wiring systems; except public address and telephone systems.
- F. Joints, splices, taps, and connections to switchboard neutral, bonding or grounding conductors, conductors to ground busses, and transformer connections for wires 6 gage and larger shall be performed with high-pressure cable connectors approved for installation with copper conductors. Connectors shall be insulated with heavy wall heat shrink WCSM, or cold-applied roll-on sleeve RVS. Insulation level shall be a minimum of 600V and joints, splices, and taps shall be qualified to ANSI C 119.1, UL, NRTL, or equal listed mechanical pressure connections.
- G. Connections to any bussing and high-press cable connectors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
- H. Connection of any bonding or grounding conductors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
- I. Wire switchboards, panel cabinets, pull boxes, and other cabinets except public address, shall be neatly grouped and tied in bundles with nylon ties at 10-inch intervals. In switchboards, panels and terminal blocks, wires shall be fanned out to terminals. If bundles are longer than 24 inches, a maximum of nine current carrying conductors may be bundled together.

- J. Install conductor lengths with a minimum length within the wiring space. Conductors must be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.
- K. Maintain the conductor required bending radius.
- L. Neutral conductors larger than 6 gage, which are not color identified throughout their entire length, shall be taped, painted white or natural gray, or taped white where they appear in switchboards, cabinet, gutters or pull boxes. Neutral conductors 6 gage and smaller shall be white color identified throughout their entire length.
- M. Fire alarm wiring shall be continuous from terminal cabinets or from equipment to each device. Splices are not permitted between devices and/or terminal cabinets at junction and pull boxes. Wiring shall be terminated at terminal blocks or devices only.
- N. Wiring systems shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of feeder and branch circuit conductor's insulation resistance. The insulation of the conductors shall be tested prior to connections to any panelboards, switchboards, variable frequency drives, lighting control systems, ballasts, and wiring devices such as but not limited to GFI receptacles, TVSS receptacles, or equipment. Insulation testing of panelboards and switchboards shall be independently performed from the insulation testing of any conductors as specified in other sections of this specification.
  - 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of feeder conductors. Tests must be conducted with wires disconnected at both ends.
    - a. Provide calibration program records to assure the testing instrument to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
    - b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
    - c. Test reports shall include the following:
      - 1) Identification of the testing organization.
      - 2) Equipment identification.
      - 3) Ambient conditions.
      - 4) Identification of the testing technician.
      - 5) Summary of project.
      - 6) Description of equipment being tested.

- 7) Description of tests.
  - 8) Test results.
  - 9) Analysis, interpretation and recommendations.
2. Utilize the services of an approved independent testing laboratory or a qualified contractor's employee (Technician certified in accordance with ANSI/NETA ETT-2000 Standard for Certification of Electrical Testing Personnel) to perform megger time-resistance insulation testing of branch circuit conductors. Tests must be conducted with wires disconnected at both ends.
    - a. Test equipment and report requirements stipulated under paragraph 3.01.N.1 apply to branch circuit testing.
  3. Tests shall be performed in the presence of the Project Inspector.
  4. Insulation resistance shall not be less than 100 mega-ohms.

### 3.02 COLOR CODES

#### A. General Wiring:

1. Color code conductor insulation as follows:

SYSTEM VOLTAGE		
Conductor	208Y/120	480Y/277
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Natural Gray

Neutrals shall be colored-distinguished if circuits of two voltage systems are used in the same raceway.

2. For phase and neutral conductors 6 gage or larger, permanent plastic-colored tape may be furnished to mark conductor end instead of coded insulation. Tape shall cover not less than 2 inches of conductor insulation within enclosure.

#### B. Signal Systems: Wires for signal systems shall be color-coded and installed under observation of the Project Inspector. Except where otherwise specified, color-coding shall be as follows:

SYSTEM	COLOR CODE
Clocks	Pink, Gray and Orange
Program Bells (some existing elementary schools)	White (Common)Black
Initiating Devices (Non-Addressable)	Red (+) and Black (-)

Program Bells (some existing secondary schools)	White (120 volt, common) Black (C.R. program) Blue (Shop program) Brown (Gym program) Yellow (Auditorium fire alarm)
Fire Alarm Horns	Pink (+) and Gray (-)
Fire Alarm Strobes	Orange (+) and Blue (-)
Un-Interruptible 24 Volt Power (Annunciator, Water Flow, and Audible Device)	Yellow (+) and White (-) Note: A single white wire may be common to both
Interruptible 24 Volt Power (4 wire smoke detectors, duct detectors)	Brown (+) and White (-) Note: A single white wire may be common to both
Switch-Leg Sprinkler Bell (Between water flow and audible device)	Violet (+) and White (-)
Door Holding Magnets (Non Power Limited)	Black (+) and White (-)

### 3.03 FEEDER IDENTIFICATION

- A. Feeder wires and cables shall be identified at each point the conduit run is broken by a cabinet, box, gutter, etc. Where terminal ends are available, identification shall be by means of heat shrink wire markers, which provide terminal strain relief. Markers shall be by Tyco Electronics, Panduit, Brady Perma-Sleeve, or equal. Identification in other areas shall be by means of wrap-around tape markers from Tyco Electronics, Panduit, Brady Perma-Code or equal. Markers shall include feeder designation, size, and description.

### 3.04 TAPE AND SPLICE KITS

- A. Splices, joints, and connectors joining conductors in dry and wet locations shall be covered with insulation equivalent to that provided on conductors. Free ends of conductors connected to energized sources shall be taped. Voids in irregular connectors shall be filled with insulating compound before taping. Thermoplastic insulating tape approved by UL, NRTL, or equal for installation as sole insulation of splices shall be furnished and shall be installed according to manufacturer's printed specifications.

### 3.05 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

### 3.06 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

### END OF SECTION

**SECTION 26 0526**  
**GROUNDING AND BONDING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Provide and install grounding system as indicated or required.
- B. Related Requirements:
  - 1. Refer to related sections for their system grounding requirements.
  - 2. Section 26 0500: Common Work Results for Electrical.
  - 3. Division 27: Communications.

**1.02 QUALITY ASSURANCE**

- A. Reference Standards:
  - 1. IEEE 142 Green Book.
  - 2. Underwriter's Laboratories (UL).
  - 3. California Electrical Code.
  - 4. Building Industry Consultant Services International (BICSI) (Signal).
  - 5. EIA/TIA (Signal and power).
  - 6. Nationally Recognized Testing Laboratory (NRTL) or equal.

**1.03 SYSTEM DESCRIPTION**

- A. Metallic objects on the Project site that enclose electrical conductors, or that are likely to be energized by electrical currents, shall be effectively grounded.
- B. Metal equipment parts, such as enclosures, raceways, and equipment grounding conductors, and earth grounding electrodes shall be solidly joined together into a continuous electrically conductive system.
- C. Metallic systems shall be effectively bonded to the main grounding electrode system.
- D. A separately derived AC source shall be grounded to the equipment grounding conductor, and to separate "made" electrode of building grounding electrode system.

- E. Electrical continuity to ground metal raceways and enclosures, isolated from equipment ground by installation of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of required size within each raceway connected to isolated metallic raceways, or enclosures at each end. Each flexible conduit over six feet in length shall be provided with a green insulated grounding conductor of required size.
- H. Metallic or semi-conducting shields and lead sheaths of cables operating at high voltage, shall be permanently and effectively grounded at each splice and termination.
- I. Neutral of service conductors shall be grounded as follows:
  - 1. Neutral shall be grounded at only one point within the Project site for that particular service. Preferable location of grounding point shall be at the service switchboard, or main switch.
  - 2. Equipment and conduit grounding conductors shall be bonded to that grounding point.
  - 3. If other buildings or structures on the Project site are served from a switchboard or panelboard in another building, power supply is classified as a feeder and not as a service.
  - 4. Equipment grounding conductor is installed from switchboard to each individual building. At building, grounding conductor is bonded with power equipment enclosures, metal frames of building, etc., to "made" electrode for that building.
  - 5. Feeder neutrals shall be bonded at service entrance point only, neutrals of separately derived systems shall be bonded at the source only.
- J. If there is a distribution transformer at a building the secondary neutral conductor shall be grounded to "made" electrode serving the building.
- K. Within every building, the main switchboard or panelboard, shall be bonded to the cold water line. Metallic piping systems such as gas, fire sprinkler, or other systems shall be bonded to the cold water line.

#### 1.04 SUBMITTALS

- A. Provide in accordance with Division 01.

#### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Furnished yard boxes shall be precast concrete and shall be approximately 14 inches wide by 19 inches long by 12 inches deep or larger, if necessary to obtain required clearances. Boxes shall be furnished with bolt-down, checkered, cast iron covers and cast iron frames cast into boxes. Yard boxes shall be Jensen Precast, Oldcastle Precast, Western Precast, Kistner , or equal.
- B. "Made" electrodes shall be copper-clad steel ground rods, minimum 3/4 inch diameter by ten feet long.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Grounding electrodes shall be installed in the nearest suitable planting area, where not otherwise indicated on Drawings, and each electrode shall terminate within a concrete yard box installed flush with finish grade. In planting areas, finish elevation of concrete yard boxes shall be two inches above planting surfaces.
- B. If concrete enclosed electrode is provided, grounding wire shall be terminated to a suitable copper plate with grounding lugs and must be enclosed in a raceway or box..
- C. Grounding rods shall be driven to a depth of not less than eight feet. Permanent ground enhancement material, (GEM) as manufactured by Erico Electrical Products, Loresco Powerset, Tessco Ultrafil or equal, shall be installed at each ground rod to improve grounding effectiveness. Install in accordance with manufacture's installation instructions.
- D. Grounding electrodes shall provide a resistance to ground of not more than 25 ohms.
- E. When installing grounding rods, if resistance to ground exceeds 25 ohms, two or more rods connected in parallel, or coupled together shall be provided to meet grounding resistance requirements.
- F. Ground rods shall be separated from one another by not less than ten feet.
- G. Parallel grounding rods shall be connected together with recognized fittings and grounding conductors in galvanized rigid steel conduit, buried not less than 12 inches below finish grade.

#### 3.02 TESTING

- A. Provide the services of an approved independent testing laboratory to test grounding resistance of "made" electrodes, ground rods, bonding of building steel, water pipes, gas pipes and other utility piping. Tests shall be performed as follows:
  1. Visually and mechanically examine ground system connections for completeness and adequacy.

2. Perform fall of potential tests on each ground rod or ground electrode where suitable locations are available per IEEE Standard No. 81, Section 8.2.1.2. Where suitable locations are not available, measurements will be referenced to a known dead earth or reference ground.
  3. Perform the two point method test per IEEE No. 81, Section 8.2.1.1 to determine ground resistance between ground rod and building steel, and utility piping - such as water, gas and panelboard grounds. Metal railings at building entrances and at handicapped ramps shall also be tested.
  4. Test shall be performed in the presence of the Inspector.
- B. Submit 3 copies of test results to the Architect. Test results shall be submitted on an official form from the independent testing laboratory recording Project location, test engineer, test conditions, test equipment data, ground system layout or diagram, and final test results.

3.03 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.04 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 26 0533****RACEWAYS, BOXES, FITTINGS, AND SUPPORTS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Raceways and wire ways.
2. Conduit installation.
3. Underground requirements.

**B. Related Requirements:**

1. Section 26 0500: Common Work Results for Electrical.
2. Section 26 0513: Basic Electrical Materials and Methods.
3. Division 27: Communications.
4. Division 28 - Electronic Safety and Security.

**C. Applicable Standards and Codes.**

1. EIA/TIA 569 Standards.
2. National American Standards Institute (ANSI).
3. National Electrical Manufacturer's Association (NEMA).
4. Nationally Recognized Testing Laboratory (NRTL).
5. California Electrical Code (CEC).
6. Uniform Building Code (UBC).
7. Underwriters Laboratory (UL).

**1.02 SUBMITTALS****A. Materials List: Provide in accordance with Division 01.****PART 2 - PRODUCTS****2.01 RACEWAYS****A. Conduit Materials:**

1. Metallic conduit, and tubing shall be manufactured under the supervision of an UL, or another NRTL factory inspection and label service program. Each ten-foot length of conduit and tubing shall bear the UL or another NRTL label and manufacturer's name.

2. Rigid metallic conduit shall be rigid steel, heavy wall, mild steel, zinc-coated, with an inside and outside protective coating manufactured in accordance with ANSI C 80.1. Couplings, elbows, bends, conduits, bushings and other fittings shall be the same materials and finish as the rigid metallic conduit. Fittings, connectors, and couplings shall be threaded type, manufactured in accordance with ANSI C 80.1 and UL 6.
  3. Electrical metallic tubing shall be steel tubing, zinc-coated with a protective enamel coating inside, manufactured in accordance with NEMA C 80.3. Fittings, couplings, and connectors shall be gland compression type, set screw couplings and connectors not permitted. All parts shall be manufactured in accordance with NEMA C80.3 and UL 6A Electrical metallic tubing is designated hereinafter as EMT. Steel and rain tight fittings shall be approved and listed for the intended application.
  4. Flexible steel conduit shall be of flexible interlocking strip construction with continuous zinc coating on strips, manufactured in accordance with UL 1.
    - a. Connectors and couplings shall be required fittings of the type, which threads into convolutions of flexible conduit.
  5. Liquid-tight flexible metal conduit shall be galvanized heavy wall, flexible locked steel strip construction, UV rated, with smooth moisture and oil-proof, abrasion-resistant, extruded plastic jacket. Connectors shall be as required for installation with liquid-tight flexible conduit and shall be installed to provide a liquid-tight connection.
  6. Non-metallic conduit shall be rigid PVC electrical conduit extruded to schedule 40 dimensions of Type II. Grade 1 high impact, polyvinyl chloride, sweeps, couplings, reducers and terminating fittings shall be listed under the UL, or another NRTL, and shall bear the manufacturer's listed marking.
  7. Multi-cell raceway shall be four inch PVC, Type 40, UL or another NRTL listed for underground use with optical fiber and signal system cables. Raceway shall be furnished with 3-1/2 inch factory installed inner ducts with required internal spacers, and required couplers, sweeps, and end bells. Multicell raceway shall be Carlon Multigard, or District approved equal.
  8. Metal Clad (MC) cable system is not allowed.
- B. Sleeves for Conduits: Sleeves shall be adjustable type by Carlon, U.S. Plastic, PEP Plastic or equal.
- C. Where conduit enters a building through a concrete foundation below grade, or ground water level, or where it is necessary to seal around a conduit where it passes through a concrete floor or wall, provide O-Z/Gedney Type FSK Thru Wall and Floor Seal, equivalent Cooper Crouse Hinds Thru-Wall, Legrand Thru-Wall, or equal.

E. Conduit Seal Fittings:

1. Provide conduit seal fittings where indicated on the Drawings. Conduit seals shall be of rigid galvanized steel. Seals in horizontal conduit installations shall be Thomas & Betts EYS, Appleton Type ESU, Crouse Hinds Type EYS, or equal. Seals in vertical conduit installations shall be Thomas & Betts EYD, Appleton Type SF, Crouse Hinds Type EYD, or equal, with continuous drain. When installing conduit seals make provision for percent fill space reduction in accordance with CEC.
2. Install sealing compound after wire has been installed. Ensure drain is not blocked in vertical seals when installing compound. Where conduit seals are installed in hazardous area applications, there shall be no conduit coupling, fitting, etc., between seal and boundary of hazardous area.

F. Surface Steel Raceway:

1. The surface steel raceway system for branch circuit wiring, data network, voice, video, and other low voltage wiring shall be as manufactured by the Wiremold Company, Hubbell, or Mono-Systems, Inc. or equal. The raceway system may be supplied pre-wired in accordance with all sections of these specifications and requirements herein, and shall be UL or another NRTL listed. Computer data installation shall be as required by other sections of this Division.
  - a. If furnished pre-wired, the system must be listed in accordance with UL or another NRTL for "Multiple Outlet Assemblies" and so labeled on interior of the assembly. The pre-wired installation must contain no extra wire splices in the raceway as compared to a contractor assembled installation assembled from components. The pre-wired steel raceway shall be Hi-Pot tested at the factory to prevent any potential bare wire or short circuit defects.
2. The raceway base, cover, and device bracket shall be manufactured of steel and finished in ivory, gray enamel or custom colors suitable for field painting to match adjacent finishes.
3. The raceway shall be a two-piece design with a metal base and snap-on metal cover, except for the Wiremold V700 system, Hubbell HBL750 series and Mono-Systems Inc. S145-700 series that shall be a one-piece design. The base and cover sections shall be a minimum of 0.040 inch wall thickness. The base section shall be available in ten-foot lengths. A hand-operated cutting tool shall be available for the base and cover to ensure clean, square cuts. Wiremold V500, Hubbell V500, and Mono Systems inc. SM500 series are not permitted.
4. A full complement of fittings shall be furnished, including but not limited to, flat internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, C-hangers and end caps. The fitting color shall match the raceway color. Fittings shall be supplied with a base where indicated

and/or required. A take-off fitting shall be furnished as required to adapt to existing flush wall boxes.

5. Device brackets shall be furnished for mounting single or two-gang devices within the raceway. Devices shall be provided with the ability of mounting flush or in conjunction with standard steel, stainless steel, or manufacturer's metal faceplates.
6. The raceway shall be furnished with a complete line of connectivity outlets and modular inserts for unshielded twisted pair including category 5, fiber-optic, coaxial, and other cabling types with face plates and bezels to facilitate installation. Computer data installation shall be as required by other sections of this Division, and Division 27.
7. Raceway shall be furnished with corner elbows and tee fittings to maintain a cable bend radius which meets the requirements of fiber-optic and copper cables under EIA/TIA 569 for communications pathways.

G. Factory Pre-Wired Surface Metal Raceway:

1. Furnish and install pre-wired surface metal raceways as indicated on Drawings and as specified.
2. Metal Raceway shall be galvanized steel Wiremold V4000, Hubbell 4000 series, or Mono-Systems Inc. SMS-4000 series complete with raceway base, cover, fittings, receptacles and mounting plates required for a complete assembly. Raceway shall have two wiring compartments with integral dividing barrier for isolating the wiring compartments.
3. Pre-wired assembly shall be UL, or another NRTL listed as a multi-outlet assembly and surface raceway as labeled on interior of assembly.
4. Wiring devices and other components shall be factory installed, electrically wired and covers labeled as indicated on drawings. Each receptacle shall be identified with panelboard and circuit number from which it was fed. Grounding shall be maintained by means of factory installed grounding conductors.
5. Where shown on Drawings, Raceway covers shall have provisions for mounting computer data outlets.
6. Complete assembly is to consist of required fittings such as elbows, slide couplings for joining raceway sections, blank end caps and flat tees.
7. Prewired assembly must contain no wire splices.
8. Receptacles and wiring shall be as indicated on drawings and as specified.
9. Where raceway is used for power and computer data outlets, installation of data outlets shall be as required by other sections of this specification.
10. Prior and during installation, verify and comply with manufacturer's installation instructions.

- 11. Entire assembly shall be tested for shorts, opens, ground faults, and wire insulation at factory and certified. Raceways shall be electrically continuous and bonded in accordance with California Electrical Code.
- 12. Submit shop drawings for approval showing the complete layout of all components of each raceway, raceway lengths, each component description, location and circuit identification.
- 13. All wiring devices shall be removable without requiring disassembly of wireway.
- 14. Standard non OEM wiring devices shall be used as specified in District's specifications.
- H. Wireways shall be 16 gage galvanized steel enclosed hinge/screw wiring troughs, surface metal raceway, wireway, and auxiliary gutter designed to enclose electrical wiring. Wireway fittings shall be furnished with removable covers and sides to permit complete installation of conductors throughout the entire wireway run. Cover shall be furnished with keyhole slots to accept captive screws locking the cover securely closed. Wireways shall be UL or another NRTL listed, and shall be Square D Type LDB NEMA-1 enclosure for interior applications, or Type RDB NEMA-3R enclosure for exterior applications, or equal by Cooper B-line, Hoffman, Wire Guard, or Circle AW.
- I. Penetration in Fire-Rated Structures: Provide 3M, or equal, sealant and fire barriers for installing fire-rated seals around penetrations through floors, walls, and elevator hoistways. Fire stop system must be UL, or another NRTL listed, and classified for through-penetration applications of metallic conduits and busways.
- J. Pull Wires: Install 1/8 inch polypropylene cords in empty or spare conduits.

### PART 3 - EXECUTION

#### 3.01 CONDUIT INSTALLATION

##### A. General Requirements:

- 1. Provide complete and continuous systems of rigid metallic conduit, outlet boxes, junction boxes, fittings and cabinets for systems of electrical wiring including lighting, power, and signal systems, except as otherwise specified.
- 2. EMT may be installed in interior concealed applications and in areas approved by owner. EMT shall not be installed in concrete, directly buried underground, outdoors, in boiler rooms, elevator pits, or where subject to damage.
- 4. Flexible Steel conduit shall not exceed 1-1/2 inches in size.
- 5. Liquid-tight flexible steel conduit shall only be installed, except where otherwise specified, for final connection of motor terminal boxes, shop equipment, cafeteria equipment, HVAC equipment and other equipment, or for frequent interchange, and shall be of sufficient length, not exceeding 36 inches, to permit full travel or adjustment of motor on its base. Liquid-tight flexible conduit shall not be used for equipment not requiring adjustment or frequent interchange.

6. Connectors for flexible metal conduit shall be made of steel, and of the types which threads into convolutions of conduit. Connectors for watertight flexible metal conduit shall be as required for installation and shall be installed to provide a watertight connection.
7. Exposed conduit shall be installed vertically and horizontally following the general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe strap.
8. If connection is from a flush wall-mounted junction box, install an approved extension box.
9. Underground feeder distribution conduits for systems may be non-metallic conduit instead of rigid conduit except where otherwise specified or indicated.
10. Conduit shall be concealed unless otherwise indicated. Conduits exposed to view, except those in attic spaces and under buildings, shall be installed parallel or at right angles to structural members, walls, or lines of building. Conduits shall be installed to clear access openings.
11. Bends or offsets will not be permitted unless absolutely necessary. Radius of each conduit bend or offset shall be as required by ordinance. Bends and offsets shall be performed with standard industry tools and equipment or may be factory fabricated bends or elbows complying with requirements for radius of bend specified. Heating of metallic conduit to facilitate bending is not permitted. Public telephone conduit bends and offsets shall be provided with a radius which is not less than ten times trade size of conduit unless otherwise permitted. Refer to underground installation, specified in this section, for radius of bends and offsets required for underground installations.
12. Running threads are not permitted. Provide conduit unions where union joints are necessary. Conduit shall be maintained at least six inches from covering of hot water and steam pipes and 18 inches from flues and breechings. Open ends of conduits shall be sealed with permitted conduit seals during construction of buildings and during installation of underground systems.
14. Where conduits are terminated in groups at panelboards, switchboards, and signal cabinets, etc., provide templates or spacers to fasten conduits in proper position and to preserve alignment. Conduits terminating at signal cabinets shall only enter cabinets in the following locations:
  - a. Conduits entering top, side, and bottom of cabinets shall be aligned in a single row, centered two inches from rear of cabinet.
  - b. Conduits entering back of cabinet shall be aligned in a single row centered two inches from top of cabinet.
  - c. Conduits shall not be spaced closer than three inches on centers.
15. Conduits above metal lath ceilings shall be rigidly suspended with pipe hangers or pipe racks or shall be secured to superstructure with factory fabricated pipe

- straps. Conduits in metal lath or steel stud partitions shall be tied to furring channels or studs. In ceiling spaces and in partitions, tie wires shall be spaced not more than 5 feet apart, shall fasten conduit tight against channels and studs at point of tie and shall not support any of conduit weight. Tie wire shall be 16 gage galvanized double annealed steel.
16. Where auxiliary supports, saddles, brackets, etc., are required to meet special conditions, they shall be fastened rigid and secure before conduit is attached.
  17. Conduit in ceiling spaces, stud walls, and under floors, shall be supported with factory fabricated pipe straps or shall be suspended with pipe hangers or pipe racks. Pipe straps shall be attached to and shall fasten conduit tight at point of support against ceiling and floor joists, rafters, and wall studs, or two-inch x four-inch headers fitted between joists or wall studs.
  18. Conduits installed on exposed steel trusses and rafters shall be fastened with factory fabricated conduit straps or clamps, which shall fasten conduit tight against supporting member at point of support.
  19. Conduits installed under buildings shall be strapped with factory fabricated conduit straps to underside of concrete floor or joists, or wood floor joists, or shall be suspended with pipe hangers or pipe racks. Conduits under building are not permitted to be placed directly on grade; they shall be suspended from building or shall be buried below surface or ground. 1-1/4 inch and larger conduits under buildings shall be installed with conduit hangers or racks.
  20. Pipe hangers for individual conduits shall be factory fabricated. Steel rods shall be 3/8 inch for two-inch conduit hangers and smaller and shall be 1/2 inch for 2 1/2-inch conduit hangers and larger.
  21. Pipe racks for groups of parallel conduits and for supporting total weights not exceeding 500 pounds shall be trapeze type and shall consist of a cross channel, Steel City Kindorf B-900, Unistrut P-1000, equivalent Cooper B-Line or equal, suspended with a 3/8 inch minimum diameter steel rod at each end. Rods shall be fastened with nuts, top and bottom to cross-channel and with square washers on top of channel. Conduits shall be clamped to top for cross-channel with conduit clamps, Steel City Kindorf C-105 or Unistrut P-1111 through P-1124, equivalent Cooper B-Line, or equal. Conduits shall not be stacked one on top of another, but a maximum of two tiers may be on same rack providing an additional cross-channel is installed. Where a pipe rack is to be longer than 24 inches, or if the supported weight exceeds 500 pounds, submit Shop Drawings of installation to the Architect for review.
  22. Conduits suspended on rods more than two feet long shall be rigidly braced to prevent horizontal motion or swaying. Installation shall meet zone 4 seismic requirements.
  23. Factory fabricated pipe straps shall be one or two-hole formed galvanized clamps, heavy-duty type, except where otherwise specified.

24. Hangers, straps, rods, or pipe supports under concrete shall be attached to inserts set at time concrete is placed, or with approved concrete anchors. Under wood, install bolts, lag bolts, or lag screws; under steel joists or trusses, install beam clamps. Contractor shall submit size of anchors, bolts, screws, and installation method to Architect for approval prior to start of any work.
25. Conduits shall be supported at intervals required by code, but not to exceed ten feet. One inch and smaller exposed conduits shall be fastened with one-hole malleable iron straps. Perforated straps and plumber's tape is not permitted for the support of conduits.
26. Conduits stubbed up through a roof or an arcade shall be flashed with a waterproof flashing. Refer to Division 07 for additional requirements.
27. Bushings and locknuts for rigid steel conduit shall be steel threaded insulating type. Setscrew bushings are not permitted.
28. Flex conduits shall be cut square and not at an angle.
29. Routing of conduits may be changed providing length of any conduit run is not increased more than ten percent of the length indicated on Drawings.

B. Underground Requirements:

1. Conduits and multicell raceways installed underground shall be entirely encased in three inch thick concrete on all sides , except where otherwise specified. Provide required spacers to prevent any deflection when concrete is placed and to preserve position and alignment. Conduits and raceways shall be tied to spacers. Anchors shall be installed to prevent floating of conduits and raceways during placing of concrete. Provide red colored concrete to encase conduits of systems operating above 600 volts.
2. Underground conduits and raceways shall be buried to a depth of not less than 24 inches below finished grade to top of the concrete envelope, unless otherwise specified.
3. Assemble sections of conduit with required fittings. Cut ends of conduit shall be reamed to remove rough edges. Joints in conduits shall be provided liquid-tight. Bends at risers shall be completely below surface where possible.
4. Conduits and raceways in a common trench shall be separated by at least three inches of concrete. Electrical power and/or lighting conduit runs installed in a common trench with conduits containing signal system wiring such as public address, telephone, intrusion detection, fire alarm, television, computer networking, and clock systems shall maintain a separation of a minimum of six inches from these types of signal system conduits and raceways. Electrical power, lighting and signal conduits and raceways installed in a common trench with other utility lines such as gas, water, sewer and storm lines shall maintain 12 inches separation from these types of utility lines.
5. The Inspector will observe underground installations before and during concrete placement. A mandrel shall be drawn through each run of conduit in presence of

the Inspector before and after placing concrete. Mandrel shall be six inches in length minimum, and have a diameter that is within 1/4 inches of diameter of conduit to be tested.

6. Non-metallic conduit installations shall comply with following additional requirements. Joints in PVC conduit shall be sealed by means of required solvent-weld cement supplied by conduit manufacturer. Non-metallic conduit bends and deflections shall comply with requirements of applicable electrical code, except that minimum radius of any bend or offset for conduits sized from 1/2 inch to 1 ½-inch inclusive shall not be less than 24 inches. Bends at risers and risers shall be PVC-coated rigid steel conduit. Radius of curve of bends or offsets in non-metallic conduit for public telephone system shall be not less than ten times trade size of conduit, unless otherwise specifically permitted.
7. Furnish and install a six-inch wide, polyethylene, red underground barrier type 12 inches above full length of concrete reading, "CAUTION ELECTRIC LINE BURIED BELOW".
8. Underground conduit systems provided for utility companies shall be furnished to meet the requirements of the utility companies requiring service.
9. Protect inside of conduit and raceway from dirt and rubbish during construction by capping openings.
10. Add bell-end bushings for conduit stub-up including underground entries to pull boxes, and manholes. Under floor standing switchboards and motor control centers provide a four-inch galvanized nipple with ground bushing.
11. Underground conduit for systems operating above 600 volts shall be a minimum size of four inches.
12. At portable classroom all stub ups shall be installed with a coupling flush to finish grade.
13. Underground conduits and raceways shall be swabbed prior to wire pull.

C. General Installation Requirements for Computer Network System Conduits:

1. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Drawings shall not be scaled to determine position and routing of wireways, drops, and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place and must be ascertained in the field before start of Work.
2. The maximum pulling tensions of the specified cables shall not be exceeded and proper radius of cable bends shall be maintained.
3. For computer network wiring, conduit types shall be limited to rigid metal conduit, electrical metallic tubing, schedule 40 PVC, multi-cell raceways, and flexible metallic conduit for lengths less than six feet.
4. Interior section of conduit run shall be not longer than 100 feet and shall not contain more than two bends of 90 degrees between pull points or pull boxes.

5. The inside radius of a conduit bend shall be at least six times the internal diameter of the conduit. When the conduit size is greater than two inches, the inside radius shall be at least ten times the internal diameter of the conduit. For fiber-optic cable, the inside radius of a conduit bend shall be at least ten times the internal diameter of the conduit.
6. Conduit shall be sized in accordance with Table 4.4-1 of EIA/ TIA 569 standard.
7. Splicing or terminating cables in pull boxes is not permitted.
8. For indoor application, a pull box shall be provided in conduit run where:
  - a. The length is over 100 feet.
  - b. There are more than two bends of 90 degrees.
  - c. There is a reverse bend in the run.
9. Boxes shall be provided in a straight section of conduit and shall not be installed in lieu of a bend. The corresponding conduit ends are to be aligned with each other. Conduit fittings shall not be installed in place of pull boxes.
10. Where a pull box is provided with raceways, pull box shall comply with the following:
  - a. For straight pull-through, provide a length of at least eight times the trade-size diameter of the largest raceway.
  - b. For angle and U-pulls:
    - 1) Provide a distance between each raceway entry inside the box and the opposite wall of the box of at least six times the trade-size diameter of the largest raceway, this distance being increased by the sum of the trade-size diameters of the other raceways on the same wall of the box.
    - 2) Provide a distance between the nearest edges of each raceway entry enclosing the same conductor of at least:
      - a) Six times the trade-size diameter of the raceway; or
      - b) Six times the trade-size diameter of the larger raceway if they are of different size.
      - c) For a raceway entering the wall of a pull box opposite to a removable cover, provide a distance from the wall to the cover of not less than the trade-size diameter of the largest raceway plus six times the diameter of the largest conductor.
  11. Drawings generally indicate Work to be installed, but do not indicate all bends, transitions of special fittings required to clear beams, girders or other Work already in place. Investigate conditions where conduits and wireways are to be installed, and furnish and install required fittings.

- D. Slabs on Grade:
1. Unless specifically reviewed by the Architect and DSA, conduits 1 ¼-inches and larger are not permitted to be installed in structural concrete slabs. Where conduits are permitted, and are installed in concrete slabs on grade, slabs shall be thickened at bottom where conduits occur to provide three inches of concrete between conduit and earth. Required excavation shall be part of the Work of this section.
  2. If concrete slab is five inches or more in thickness with a moisture barrier plastic sheet between earth and slab, one inch and smaller conduits shall be installed in the slab with a minimum of one inch concrete between earth and conduit.
- F. Concrete Walls, Beams, and Floors: Provide sleeves where conduits pierce concrete walls, beams, and floors, except floor slabs on grade. Sleeves shall provide 1/2 inch clearance around conduits. Sleeves shall not extend beyond exposed surfaces of concrete and shall be securely fastened to forms. Where conduits pass through walls below grade, seal with required sealant and backer materials between conduit and sleeve to provide a watertight joint. Sealant shall be as indicated in Section 07 9200: Joint Sealants.
- 3.02 STUBS
- A. Panelboard: Install two one inch conduits from each flush mounted panelboard to access under floor space and to access above ceiling space where these conditions occur. Cap conduits with standard galvanized pipe caps.
- B. Floor: At points where floor stubs are indicated in open floor areas, for connections to machines and equipment, conduits shall be terminated with couplings, tops flush with finished floor. Stubs shall extend above couplings the indicated distance. Where capped stubs are designated, couplings shall be closed with cast iron plugs with screw drive slots.
- C. Underground:
1. Underground conduit stubs shall be terminated at locations indicated, and shall extend five feet beyond building foundations, steps, arcades, concrete walks and paving. Rigid metallic conduit stubs and non-metallic conduit stubs shall be capped by installing a coupling flush in end wall of concrete encasement and plugging with a permitted plug. Project record drawings shall indicate location of ends of underground conduit stubs fully dimensioned and triangulated with reference to buildings or permanent landmarks. These dimensions, including depth below finished grade, shall be marked on project record drawings in presence of the Inspector before backfilling trench. Where extending existing concrete encased stubs, clean, chip and wire brush end of existing concrete and brush on a heavy coat of neat cement paste or epoxy bonding agent.
  2. Over ends of individual underground conduit stubs or groups of conduit stubs, install four-inch by 18-inch deep PVC filled with concrete, flush with finished grade in asphaltic concrete or lawns, and two inches above finished grade in planting areas. Cast a three-inch by three-inch brass plate engraved "ELECT"

flush in top of concrete. Secure plate to concrete with brass dowels or as indicated on drawings.

3.03 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.04 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 26 0800**

**ELECTRICAL SYSTEMS COMMISSIONING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

**A. Section Includes:**

1. General requirements for Commissioning (Cx) of lighting systems components, lighting controls and HVAC systems line voltage interconnection components, including installation, start-up, testing and documentation according to Construction Documents and Commissioning Plan (CxP).
2. Standard procedures for the execution of commissioning work shall be in conformance with Division 1, Section 01 9113 General Commissioning Requirements. Coordinate work with the Commissioning Agent (CxA).

**1.02 RELATED REQUIREMENTS:**

1. Division 01 - General Requirements.
2. Section 01 9113: General Commissioning Requirements.
3. Section 01 7900: Maintenance and Operations Staff Demonstration and Training.
4. Section 26 0500: Common Work Results for Electrical.
5. Section 26 0513: Basic Electrical Materials and Methods.
6. Section 26 0526: Grounding and Bonding.
7. Section 26 0519: Low Voltage Wires (600 Volt AC).
8. Project Commissioning Plan.
9. LAUSD Basis of Design (BOD).

**1.03 REFERENCES**

**A. Applicable codes, standards, and references: inspections and tests shall be in accordance with the following applicable codes and standards:**

1. National Electrical Testing Association – NETA.
2. National Electrical manufacturer's Association – NEMA.
3. American Society for Testing and Materials – ASTM.
4. Institute of Electrical and Electronic Engineers – IEEE.
5. American National Standards Institute – ANSI.
6. National Electrical Safety Code – NESC.

7. California Building Code – CBC.
8. California Electrical Code – CEC.
9. California Green Building Standards Code (CalGreen).
10. United States Green Building Council, Leadership Energy and Environmental Design (USGBC) (LEED).
11. Conglomerate for High Performance Schools (CHPS).
12. Insulated Power Cables Engineers Association – IPCEA.
13. Occupational Safety and Health Administration – OSHA.
14. National Institute of Standards and Technology – NIST.
15. National Fire Protection Association – NFPA.
16. ANSI/NFPA 70 – National Electrical Code.
17. ANSI/NFPA 70B – Electrical Equipment Maintenance.
18. NFPA 70E – Electrical Safety Requirements for Employee Work Places.
19. ANSI/NFPA 101 – Life Safety Code.

#### 1.04 SUBMITTALS

- A. Submittals shall include the following:
1. Submit required Cx submittals in accordance with Division 1 Specification Sections.
  2. Copy of the Architect's reviewed and accepted submittals to the CxA via the OAR.
  3. List of team members who will represent the Contractor in the Pre-functional Equipment Checks and Functional Performance Testing, at least two weeks prior to the start of Pre-functional Equipment Checks.
  4. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of Owner-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of Owner to keep Warranty in force, clearly defined.
  5. Detailed manufacturer's recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by Contractor's specific procedures, and Pre-functional Tests, at least four weeks prior to the start of Pre-functional Performance Tests.
  6. After facility's commission is complete, submit completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

#### 1.05 MEETINGS, SEQUENCING AND SCHEDULING

- A. Sequencing and Scheduling: The work described in this Section shall begin only after work required in related Division 26 Sections has been successfully completed, and tests, inspection reports and Operation and Maintenance manuals required in Division 26 Sections have been submitted and approved. The start-up and Pre-functional Equipment Checklists shall be completed and submitted to the Owner's Authorized Representative (OAR) prior to the Functional Performance Tests. Refer to the project Cx Plan for more details.
1. Coordinate electrical work with the work of other trades prior to scheduling of any Cx procedures.
  2. Coordinate the completion of electrical testing, inspection, and calibration prior to start of Cx activities.
  3. Cx activities shall be scheduled in accordance with project's Cx plan.

#### 1.06 QUALITY CONTROL

- A. Comply with Owner's Quality Control Specifications, Sections 01 4516 – 01 4519, as applicable.
- B. Incorporate manufacturer's recommended Cx procedures for the systems and equipment to be commissioned under this Section.

### PART 2 - PRODUCTS

#### 2.01 TEST EQUIPMENT

- A. Equipment to be utilized in the commissioning process shall meet the following requirements:
  1. Provide test equipment as necessary for the equipment and systems to be commissioned.
  2. Provide testing equipment and accessories that are free of defects and certified for use.
  3. Provide testing equipment with current calibration labels per NIST Standards.
  4. Testing equipment shall be UL Listed.

### PART 3 – EXECUTION

#### 3.01 COMMISSIONING PROCESS REQUIREMENTS

- A. Work to be performed prior to commissioning:
  1. Complete all phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.
  2. Start-up services required to bring each system into full operational state and ready for functional performance testing:
    - a. Completion of prefunctional checklists.

- b. Manufacturer's Authorized Representative Start-up as required
  - c. Contractor start-up
  - d. Testing.
  - e. Control sequences of operation.
  - f. Full and part load performance.
3. If modifications or corrections to the installed systems are required to bring the system(s) to acceptance levels due to Contractor's incorrect installation or defective materials, such modifications or corrections shall be made at no additional cost to the Owner.
  4. Start-up services required to bring each system into full operational state and ready for functional performance testing:
    - a. Completion of prefunctional checklists.
    - b. Manufacturer's Authorized Representative Start-up as required
    - c. Contractor start-up
    - d. Testing.
    - e. Control sequences of operation.
    - f. Full and part load performance.
  5. Commissioning shall not start until each system is complete and the above items are completed and approval has been received by the OAR

B. Commissioning Process Requirements:

1. Refer to Section 01 9113 General Commissioning Requirements, related sections and Cx Plan for information on meetings, start-up plans, Pre-Functional and Functional Performance Testing (FPT), operations and maintenance data, and other Commissioning activities.

**3.02 PREPARATION**

- A. Provide certified electricians or other qualified personnel as required with tools and equipment necessary to perform Cx activities.
- B. Provide equipment manufacturer's factory representative(s) for commissioning of classrooms lighting and its control system, Theatrical Lighting Controls, and Energy Management and Environmental Control Systems as required by the Cx Plan.
- C. Provide certified testing agency personnel or report(s) as required in the Cx Plan.

**3.03 TESTING**

- A. Testing documentation shall include the following minimum information:
  1. Test number.
  2. Equipment used for the test, with manufacturer and model number and date of last calibration.

3. Date and time of the test.
  4. Indication of whether the record is the first commissioning test or a retest following correction of a previously identified problem or issue.
  5. Identification of the system, subsystem, assembly, or equipment.
  6. Conditions under which the test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of the test.
  7. Systems and assemblies test results, performance and compliance with contract requirements.
  8. Issue number, if any, generated as the result of the test.
  9. Name and signature(s) of witnesses and the person(s) performing the test.
1. Acceptance Criteria:
- a. Lighting Controls: For the conditions, sequences and modes tested, the dimming, occupancy, photocell, and timing controls, integral components and related equipment respond to changing conditions and parameters appropriately as defined in the Contract Documents.
  - b. Illumination Levels: Average light levels in the tested space at the work plane elevation shall not be less than ten percent below nor greater than 20 percent above the specified light level range for the space.
  - c. Lighting Power Density: Average instantaneous lighting power density is plus or minus ten percent of that indicated in the Construction Documents. Power factors on lighting circuits shall be 0.95, or as required by lighting fixture specifications.
2. Sampling Strategy for Identical Units:
- a. Lighting Controls: Test automatic interior lighting controls.
  - b. Illumination Levels: At least 50 percent of space zones and rooms, chosen by the Owner, shall be verified as realizing proper light levels. If 25 percent of the spaces in the first sample fail the Functional Performance Tests, test another ten percent of the untested space zones and rooms (the second sample). If ten percent of the spaces in the second sample fail, test remaining spaces.
  - c. Power Density: Test lighting circuits.
- D. Participate and perform Cx related testing requirements prescribed under Sections 01 9113 and the approved project Cx Plan.

3.04

**ADJUSTING**

- A. Systems improperly adjusted, incorrectly installed equipment or deficient Contractor performance may result in additional work being required for Cx acceptance.
  - 1. Perform work required to correct installations not meeting contract requirements at no additional cost to the Owner.
- B. Corrective work shall be completed in a timely manner to permit completion of the Cx process.
  - 1. Refer to the Cx Plan for retesting requirements necessary to achieve required system performance.
  - 2. If the systems' Cx deadline, as defined in the Cx Plan, goes beyond the scheduled completion of Commissioning without resolution of the problem, the Owner reserves the right to obtain supplementary services or equipment to resolve the problem.

### 3.05 TRAINING

- A. Provide training and documentation as required in applicable Division 26 specification sections, and other related sections.

END OF SECTION

## SECTION 27 0126

TEST AND ACCEPTANCE REQUIREMENTS  
FOR STRUCTURED CABLING

## PART 1 - GENERAL

## 1.01 SUMMARY

- A. Principal items of work in this section include but are not limited to:
1. Ensure quality assurance, testing and final acceptance requirements for premises cabling and wireless installations comply with industry standards and Project Construction Documents.
  2. The Los Angeles Unified School District (LAUSD) seeks to improve the quality of its network installations. In order to achieve this objective, the guidelines specified below are to serve as a technical reference for the Owner's infrastructure verification and acceptance of the Contractor's testing. The appendix of this section describes specific test procedures that the Owner shall perform during the acceptance testing, particularly those involving LAN, PBX, VTC, and Convergence equipment, and associated cable plants. The procedures provide a comprehensive series of visual, electronic, and optical tests to ensure the infrastructure installation complies with the standards set forth in the specifications. The successful culmination of these tests shall be used to document a physical configuration audit (PCA) as part of the Owner's Quality Assurance (Q/A) Report. Testing shall include physical Q/A review of installation and performance testing of components.
- B. Responsibilities for this specification are as follows:
1. Installer: The Contractor shall follow ANSI/TIA and BICSI installation standards. The Contractor shall perform horizontal cable installation including Category 5e and Category 6 unshielded twisted pair (UTP) cable runs terminated in the communications cabinet and cable terminations at each work area outlet, vertical cable installation, and fiber optic cable runs and terminations. During installation the Contractor shall perform tests as required by the Parent Specification and in compliance with testing standards found in Appendixes B, C, and D of this Section. The Contractor shall notify the Project Inspector 48 hours in advance of any required testing so that the Project Inspector can notify the Owner's Quality Assurance Team to observe the Contractor's test procedures. The Contractor shall forward test documentation to the OAR prior to the Owner's formal acceptance testing.

2. Contractor's Site Responsibilities during formal Owner's Quality Assurance: During formal Owner's Quality Assurance, the Contractor and his/her Subcontractor shall comply with testing standards and requirements detailed in Appendices A through F. Under the guidance of the Project Inspector and in coordination with the Owner's Quality Assurance Team, the Installer shall:
  - a. Verify LAN connectivity and WAN extension cabling to MDF.
  - b. Configure the router(s) and switch(es) in compliance with the Contract Documents.
  - c. Aid the Owner's Quality Assurance Team with network cut over. (For example: existing systems with internet connectivity and administration systems including but not limited to SIS and payroll).
  - d. Provide labor, materials, and testing equipment (For example: Power Meter, OTDR) to correct any deficiencies with labeling, cable charts, terminations, and Installer supplied test results.
  - e. Provide keys and access to installed network equipment.
3. Owner's Quality Assurance Team Responsibilities: Using the procedures specified in the Appendixes of this guideline, the Owner's Quality Assurance Team shall verify that the infrastructure installed under the Contract complies with the installation standards detailed in the Specifications. Specifically, testing shall be performed by the Owner on vertical and horizontal cable, (For example: fiber optic, Category 5e UTP and Category 6 UTP) along with component installations performed under the scope of the overall infrastructure effort (For example: Ethernet switches and routers). Generally, testing specifications and procedures cover the following:
  - a. Q/A review of equipment rack installation; including placement in the communications cabinets, attachment to the floor, and seismic bracing.
  - b. Q/A review of fiber terminations, patch panel installation, cable labeling, and cable bundling.
  - c. Q/A review of Category 5e and Category 6, T568B terminations, including cable end connections at the patch panel and work area outlets.
  - d. Q/A review of the Contractor's Redlines for accuracy.
  - e. Industry standard for fiber optic, Category 5e and Category 6 cable performance testing.
  - f. Network equipment performance verification.

- g. Uninterruptible power supply performance verification.
- h. Communications cabinet layout and facility drop count verification.

C. Related Requirements:

1. Section 00 7000: General Conditions.
2. Section 01 7700: Contract Closeout.
3. Section 06 1000: Rough Carpentry.
4. Section 26 0500: Common Work Results for Electrical.
5. Section 26 0513: Basic Electrical Materials and Methods.
6. Section 26 0526: Grounding and Bonding.
7. Section 26 0533: Raceways and Boxes Fittings and Supports.
8. Section 26 2416: Panelboards and Signal Terminal Cabinets.
9. Section 27 1013: Structured Cabling (Existing Sites).
10. Section 27 4135: Television Systems -Fiber Optic Distribution.
11. Section 27 5128: Public Address Systems (Auditoriums, Performing Art, M-P Rooms)(MS and HS).
12. Section 31 2323: Excavation, and fill for Utilities.

D. Acronyms:

dB	Decibel
IDF	Intermediate Distribution Facility
ITD	Information Technology Division
LAN	Local Area Network
LAUSD	Los Angeles Unified School District
LDC	Local Distribution - Classroom
LDF	Local Distribution Facility
MDF	Main Distribution Facility
MPOE	Minimum Point of Entry
NVP	Nominal Velocity of Propagation
OAR	Owner Authorized Representative
PA	Public Address
PBX	Private Branch Exchange
QA	Quality Assurance

UTP	Unshielded Twisted Pair
VoIP	Voice over Internet Protocol
WLAN	Wireless Local Area Network

## 1.02 CODES AND STANDARDS

- A. ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises.
- B. ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard, current issue.
- C. ANSI/TIA-568-C.2 Balance Twisted-Pair Telecommunications Cabling and Components Standards.
- D. ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standards.
- E. ANSI/TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling.
- F. EIA/TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces and all current addenda.
- G. ANSI/EIA/TIA-598-A, Optical Fiber Cable Color Coding, current issue
- H. EIA/TIA-606A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- I. ANSI-J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications.
- J. EIA/TIA-OFSTP-14A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
- K. ANSI/TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard, current issue in accordance with TIA TR-42.4.
- L. EIA/TIA-OFSTP-7, Optical Power Loss Measurements of Installed Single mode Fiber Cable Plant.
- M. American National Standards Institute (ANSI)/EIA/TIA-455-59, Field Testing.
- N. FCC Part 68.
- O. National Electrical Manufacturer's Association (NEMA).
- P. National Fire Protection Association (NFPA), NFPA-70.
- Q. CCR Part 3 - California Electrical Code (CEC).
- R. CCR Part 2 - Uniform Building Code (UBC).
- S. Building Industry Consulting Services International (BICSI) TDMM, most recent revision.
- T. Institute of Electrical and Electronic Engineers (IEEE).
- U. Other Codes and Standards as defined in the Parent Specification.

- V. Fluke Networks DTX Series Cable Analyzer Technical Reference Handbook 01/11 or newer.

1.03 PUNCH LIST

- A. Per OAR request, The Owner's Quality Assurance Team shall assist in the Punch List for IT and low voltage systems and provide it to the OAR.

1.04 QUALITY ASSURANCE

- A. Owner's Quality Assurance Test Schedule:

1. The Project Inspector shall schedule the Owner's Quality Assurance test after review of the Contractor's complete Test Results of the school.

**PART 2 - MATERIALS - NOT USED**

**PART 3 - EXECUTION**

3.01 EQUIPMENT INSTALLATION

- A. The Installer is responsible for basic installation and cross connection of LAN equipment required by the Contract Documents.
- B. The Owner's Quality Assurance Team shall verify that basic installation is complete and functional.

END OF SECTION

## *LAUSD Quality Assurance Guidelines*

### **APPENDIX A - QUALITY ASSURANCE PROCEDURES**

#### **A.1 Overview of Quality Testing Procedures**

This appendix provides guidelines for visual Quality Assurance reviews of each site. The Owner's Quality Assurance Team shall examine the Work based upon the guidelines outlined in the following appendixes and their associated forms.

1. Communications Cabinet Review. Verify the design and compliance with contract documents. This may include: ANSI/TIA and BICSI cabling practices, standard and specific labeling practices, and safe and logical equipment and wire management placement.
2. Cable Plant Review. Cabling from the Communications cabinet, at various points along the cable path, and in functional work areas for compliance with ANSI/EIA installation specifications including ANSI/TIA-568-C and TIA/EIA-569 and documents referenced therein and professional installation practices.
3. User Work Area Quality Assurance Review. Cabling at the user wall plate location in the functional work areas for compliance with ANSI/EIA installation specifications including ANSI/TIA-568-C and TIA/EIA-569 and documents referenced therein and professional installation practices.
4. Redline As-Built Documentation shall be compared to physical installation. Deviations shall be noted and the Quality Assurance procedure halted until discrepancies have been rectified.

#### **A.2 General Quality Assurance Guidelines**

The Owner's Quality Assurance Team visually reviews the installation to verify that cabling is supported properly. Cable trays or structural ties shall support cable. No cable shall have been installed in pathways near sharp edges or objects that might cause damage. Cable shall not be supported by, on, or attached to a dry wall ceiling, ceiling tiles, ceiling grid, routed over pipes, conduit, lighting fixtures, or other wiring. The Owner's Quality Assurance Team should be able to determine the total number of drops dispersed from each communications cabinet, the number of drops for each supported room, and the agreed-upon labeling scheme for the site. The Installer should have met the following general labeling guidelines:

- Clearly labeled each drop number and Communications cabinet on the wall jack faceplate.
- Label each horizontal cable jacket using a permanent label at the workstation end, inside the wall, and the patch panel end no more than two inches from each end.
- At workstation end: communications cabinet, drop, and termination panel.
- At patch panel end: drop and cabinet numbers.

## *LAUSD Quality Assurance Guidelines*

- Label each patch panel port with drop number and cabinet number.

Because work area room numbers may have been modified since the design, the installer shall provide as built documentation for each communications cabinet; reflecting the room numbers used in the labeling scheme as a reference point. The Contractor and his/her Subcontractor shall use these working prints to produce post-installation as-built drawings.

### **A.3 Deficiency Reports**

Before beginning any test, the Owner's Quality Assurance Team shall view any deficiency report(s) (DR) that have been filed with the OAR and Project Inspector. The Owner's Quality Assurance Team shall review the DR(s) as part of the Quality Assurance review to ensure the required corrective actions have been taken.

### **A.4 Quality Assurance Test Procedures**

The Owner's Quality Assurance Team shall follow the acceptance test and performance criteria outlined in ANSI/TIA-568-C, OFSTP-14A, OFSTP-7 and shall conduct acceptance and performance testing following each manufacturer's specification on their respective network components to verify compliance with manufacturer's installation instructions.

The Owner's Quality Assurance Team shall also follow any specific local policy directives or instructions regarding installation practices and acceptance testing identified during the site orientation visit. The details for the design of a particular location shall also comply with any related State, County and Municipal standards.

### **A.5 Construction Quality Assurance of Work:**

During the installation of low voltage systems, upon request by the OAR, the Owner's Quality Assurance Team shall examine the following:

1. General to Low Voltage Systems:
  - a. Conduit and raceway layout and installation for each low voltage system and verify that they meet project specifications.
  - b. Equipment rack installation, including placement in the communications room, seismic bracing, and attachment to the floor.
  - c. Cable punch-downs, patch panel installation, cable cross-connection, cable labeling, and cable bundling.
  - d. Verify proper equipment installation, cable cross connection, system configuration, and testing.
  - e. Verify system layout and device location(s) match the locations shown on the as-builds.

### ***LAUSD Quality Assurance Guidelines***

- f. Active components, terminal cabinets, cross connects; splices, etc. are located in a secure interior location.
  - g. Verification of Uninterruptible power supply performance.
  - h. Verification of proper air conditioning in MDF and IDFs. Room temperature should maintain between 65 - 72 degrees seven days per week, 24 hours per day.
  - i. Terminations punched down singly and cross-connected on 66 blocks. 66 blocks are primarily used in Public Address systems and Intercom. PBX cable plants are specified to use 110-blocks exclusively, except for one termination block used for the PA interface cabling.
2. LAN, verify the following:
    - a. Examine Category 5e and Category 6, T568B terminations, including cable end connections at the patch panel and wall drop receptacles.
    - b. Examine fiber terminations and fiber termination boxes.
    - c. Examine Installer's basic network components installation and operation.
    - d. Review customized configuration and test results.
    - e. Test overall network operation to ensure it meets Owner's strategic planning and acceptable performance level.

#### **A.6 Start Up**

Start-up work is to be completed as a condition for Substantial Completion. Start-Up is to include the testing and commissioning of equipment and systems.

1. After start up has been completed but prior to Substantial Completion, the Project Inspector shall schedule the Owner's Quality Assurance Team site visit.
2. The Owner's Quality Assurance Team shall review documentation and test results for completeness.
3. The Owner's Quality Assurance Team shall visit the site and verify the Contractor's test results by the Quality Assurance procedures detailed herein.

#### **A.7 Contract Completion and Process Review**

The Quality Assurance Team shall review the entire Quality Assurance process and recommend changes to improve it on an as needed basis.

#### **A.8 Test Procedures**

## ***LAUSD Quality Assurance Guidelines***

1. Visual Q/A Reviews
  - a. The Owner's Quality Assurance Team shall conduct a visual review of the installation including the communication cabinet, cable runs, and user work areas. Appendix A documents these Q/A review procedures.
2. Cable Performance Testing
  - a. The Owner's Quality Assurance Team shall test 100 percent of the fiber optic Backbone cable, a random sample of Category 5e and Category 6 UTP cable and the fiber optic Horizontal cable. Appendix C outlines these specific tests.
    - (1) Test Cable Sampling: The Owner's Quality Assurance Team shall randomly test 10 percent of installed horizontal cables from each communication cabinet on site. For example, if a communications cabinet has 100 drops, the Owner's Quality Assurance Team shall test a minimum of 10 drops for each cabinet. Where random testing shows a failure rate of more than 1 percent of the drops (2 in 10 of the random sample), an additional 10 percent of the installed horizontal cabling shall be tested. Appendix B outlines these specific tests.
    - (2) Cable Testing: The Owner's Quality Assurance Team shall perform the following industry-standard operational and performance cable testing detailed in ANSI/EIA-568-C.
      - (a) Wire map
      - (b) Length verification
      - (c) Insertion loss (attenuation)
      - (d) Near-end crosstalk (NEXT)
      - (e) Power sum near-end crosstalk (PSNEXT)
      - (f) Equal level far-end crosstalk (ELFEXT)
      - (g) Power sum equal level far-end crosstalk (PSELFEXT)
      - (h) Return loss
      - (i) Propagation delay
      - (j) Delay skew
3. Network Equipment Testing

## ***LAUSD Quality Assurance Guidelines***

- a. The Owner's Quality Assurance Team shall perform network tests on hardware components for proper installation, per manufacturer's recommendations and configuration. Components shall be tested separately for initial power up and their ability to maintain system configuration. The specific test for network equipment components is described in Appendix D.

### **A.9 Acceptance Criteria**

1. An overall Pass or Fail condition shall be determined by the results of the required individual test. Any Fail and Fail\* shall result in an overall Fail. In order to achieve an overall Pass condition, individual results shall be Pass or Pass\*. A Pass or Fail result for each parameter is determined by the allowable limits for that parameter. The test result of a parameter is marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer shall provide documentation as an aid to interpret results marked with asterisks.
2. Cable plant acceptance by the Owner requires 100 percent passing results for cable samples and corrected cabling deficiencies. Acceptance of other components is based upon satisfactory completion of a test configuration scenario, as defined in the appropriate appendix to this plan.

### **A.10 Corrective Procedures**

1. EIA/TIA testing specification details a pass/fail criterion, i.e., if a fiber optic cable is outside of specifications, the test fails. The Owner's Quality Assurance Team shall identify any deficiencies found during Quality Assurance (e.g., a cable or component failing a test) to site personnel before the Owner's Quality Assurance Teams departure and shall document these deficiencies in the Quality Assurance Report. If the link attenuation for any fiber optic cable strand is outside acceptable loss as specified in ANSI/EIA-568-C, the Installer shall re-complete the terminations required to reduce the amount of attenuation. If re-termination fails, the Installer shall be required to take steps up to and including the replacement of the cable to eliminate the testing deficiency. After corrective action, the Owner's Quality Assurance Team shall retest repaired fiber runs and document the results in the Quality Assurance Report.
2. The Owner's Quality Assurance Team shall identify to the Owner in writing any deviation from acceptable ANSI/TIA specifications for cabling resulting in a test failure. The Owner may choose to accept the deficiency via a written waiver. For example, if a fiber optic connection exceeds the allowable termination attenuation by 0.1 decibels (dB), but the total link attenuation is within the length attenuation budget, the Owner may choose to waive the specification. Other components (e.g., switches or routers) must function according to the specified configurations in the final Work Plan for Owner LAN projects.

***LAUSD Quality Assurance Guidelines***

**A.11 Quality Assurance Reporting**

1. Acceptance Recommendation
  - a. At the conclusion of testing, the Owner's Quality Assurance Team shall provide a recommendation to Owner to accept or not accept the installation.
2. Quality Assurance Report
  - a. The Owner's Quality Assurance Team shall deliver a Quality Assurance Report to the project OAR no later than seven (7) working days after completion of testing. This report shall include:
    - (1) A written test report for visual installation tests.
    - (2) Electronic test results of cable testing including verified cable lengths, test personnel, test date, and individual test description.
    - (3) Each detected deficiency with its correction date and retest results, if accomplished.
    - (4) Network operational test results for the switch(s) and router connections.
    - (5) Any condition(s) precluding strict adherence to CEC, ANSI/TIA, and BICSI installations or Quality Assurance standards shall be marked for potential Owner waiver before system acceptance.
    - (6) A summary confirming the acceptance recommendation given.

**A.12 Test Equipment**

1. The Owner's Quality Assurance Team shall use the following test equipment or their equivalent during testing.
  - a. Fluke DTX 1800, or equal, tester with single-mode and multi-mode power meter and light source heads.
  - b. Fluke DTX 1800 OTDR module, Optifiber Optical Time Domain Reflectometer (OTDR), or equal.
  - c. Personal computer with Transmission Control Protocol/Internet Protocol (TCP/IP) protocol stacks.
  - d. Thermometer

***LAUSD Quality Assurance Guidelines***

Table 2.6.1 T & A Checklist for Owner's Quality Assurance Team Projects

Site Location Code / Name	OAR
Network Engineer	Insp ector
OAR Recommendation	Electrical Inspector

Review Item	Yes	No	N/A	Pass/Fail
Have deficiencies been cleared by the Project Inspector or OAR?				
Has the vendor provided cable charts in the cabinets?				
Are there any horizontal cables over 90 m?				
Do the cable runs used agree with the cable routing drawings?				
Are the cables routed and terminated per specification?				
Are cable run penetrations terminated to preclude strain on the installed cable?				
Are the copper and fiber optic cables installed per the manufacturer's recommendation?				
Is each cable clearly labeled at the user's location?				
Is each port on the patch panel labeled with the corresponding user outlet location?				
Are cable and patch panel labels securely fastened and easily readable?				
Are the fiber cables in the fiber termination box labeled per the approved labeling scheme and immediately adjacent to each termination within the fiber termination box?				
Is the cable for each drop identified with the correct labeling scheme at or near the point of termination?				
Does the user outlet plate display the correct labeling scheme and match the distant end label?				
Are connectors free of exposed metal, loose connectors, or other problems?				
Is the cable jacket stripped back only as far as required to terminate on connecting hardware?				
Is the physical plant installed in accordance with specifications of this project?				
For traditional, hierarchical star cable plants following 27 1013 specification, are there at least 50 percent spare Backbone strands, in multiples of 6 strands, to each IDF from the MDF?				
For new fiber optics cable plant installations following 27 1014				

### ***LAUSD Quality Assurance Guidelines***

specification, are there at least 15 percent spare Backbone strands, in multiples of 6 strands, to each IDF from the MDF?				
Does this site have an existing Local Area Network?				
Are the T1 lines correctly installed and ready to cut over? Also, has the extension to the MDF been installed?				
Will the site reutilize an existing router? If yes, specify exact model / serial number.				
Is the router configured and ready for cut over?				
Are the required amounts of GB Uplinks provided to accommodate the equipment installed including port expansion?				
Are classroom and administration switches mounted, connected, and operational?				
Has the vendor provided inventory and the drop count been verified or has an Inventory document been completed? If so, please attach.				

#### **A.13 Visual Q/A Review Worksheets**

The following pages provide the three visual Quality Assurance worksheets:

1. Communications Cabinet Quality Assurance Review Form
2. Cable Routing Quality Assurance Review Form
3. User Work Area Quality Assurance Review Form

***LAUSD Quality Assurance Guidelines***

**A.13.1 Communications Enclosure Quality Assurance Review Form**

Site _____	Date _____	Quality Assurance Rep(s) _____
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Q/A REVIEW ITEM	PASS	FAIL
Is the cabinet ready for a Q/A review? If not, list discrepancies (e.g., debris, punch-list, or un-terminated cable).		
Is the installation performed in the planned communications cabinet?		
Are there clearly identified final or redlined drawings showing the "as-built" installation?		
With devices operating, are ambient cabinet and room temperatures within 50-80° F? The temperature is: _____.		
Are heating, ventilation, and air conditioning (HVAC), lighting, and electrical outlets installed per contract? Are the requirements addressed in the Site Concurrence Memorandum or other documentation?		
Are cabinet rails and wire managers installed so as to preclude any space problems with the UPS?		
Are the cabinets seismically braced to the floor and/or wall?		
Is there adequate space around the racks and fiber termination panel for maintenance?		
Are patch panels, wire management panels, and network equipment properly affixed to the rack?		
Is debris cleaned from inside of cabinets?		
Are cable run penetrations installed so fire barriers are maintained in cabinet locations?		
Are cable run penetrations properly and securely fastened to supporting structures?		
Are cable run penetrations terminated to preclude strain on the installed cable in cabinet locations?		
Are cables routed and punched per specification and industry standards?		
Is each cable clearly labeled with the corresponding user location per specification?		
Is each port on the patch panel labeled with the corresponding user location per specification?		
Are cable and patch panel labels securely fastened and easily readable per specification?		
Is there ½-inch or less of untwisting on any cable pair at the termination point?		
Is the UTP cable jacket stripped back only as far as required to terminate on connecting hardware?		
Is a bend radius of at least 1-inch maintained for sheathed UTP cable?		
Is the fiber optic cable free from excessive strain or stress, sharp bends, or kinks?		
Are service loops in place at each end of the cable?		
Are the fiber cables in the fiber termination unit? Is the box labeled per the approved labeling scheme and immediately adjacent to each termination within the fiber termination		

*LAUSD Quality Assurance Guidelines*

box?		
Is excess fiber optic cable coiled in the termination box so it does not exceed the minimum bend radius per manufacturer's recommendations and specifications?		
Are fiber optic patch cords neatly routed to the network equipment via wire management?		

**A.13.2 Cable Routing Q/A Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_

Q/A REVIEW ITEM	PASS	FAIL
Are cable bundles either secured to the wall or to a non-electromagnetic interference-producing source or hung from the ceiling (e.g., suspended via cable trays, inner duct, J-hooks, D-rings, or ladder rack) per specification or best industry standards?		
Do the cable runs used agree with the redline drawings?		
If not, are accurate redlined drawings available showing the cable routing?		
Is debris from the cable run penetrations adequately cleaned up per specification?		
Is the fiber optic cable runs completely contained within inner duct? Where?		
Notes:		

***LAUSD Quality Assurance Guidelines***

**A.13.3 User Work Area Q/A Review Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_

<b>Q/A REVIEW ITEM</b>	<b>PASS</b>	<b>FAIL</b>
Are wall jack faceplates professionally installed and finished?		
Is cabling precluded from view on the external surface of walls (e.g., ducting used on solid core walls)?		
Does the user outlet plate display the correct labeling scheme?		
Is the cable for each drop identified with the correct labeling scheme and within 2 inches of termination per specification?		
Is the cable installed in a manner that precludes cable strain?		
Are connectors insulated from surrounding cable and objects (e.g., are cable barrel adapters, connectors, devices, and terminators insulated from any earth ground or current-conducting surfaces of the building structure)?		
Are connectors free of exposed metal, loose connectors, or other problems?		
Is there $\frac{1}{2}$ -inch or less of untwisting on any cable pair at the termination point?		
Is the cable jacket stripped back only as far as required to terminate on connecting hardware?		
Is a bend radius of at least 1-inch maintained for sheathed UTP cable?		
Is the 4 or 6 strand fiber secured properly in the LDFs and LDCs?		
<b>Notes:</b>		

## *LAUSD Quality Assurance Guidelines*

### **APPENDIX B - CATEGORY 5E AND CATEGORY 6 UTP CABLE PERFORMANCE TESTS**

#### **B.1 Overview of Cable Tests**

This appendix provides guidelines for electronic testing of Horizontal Category 5e UTP wiring. The Owner's Quality Assurance Team shall meet the guidelines outlined in the following Q/A review and its associated forms.

- Electronic Testing. This testing verifies that the standard performance parameters for the UTP cable as outlined in ANSI/EIA-568-C are within the specifications as noted below. Refer to Premise Wiring Specification.

#### **B.2 Test and Support Equipment**

1. The types of cable to be tested are as follows :
  - a. Category 5E/6 UTP shall be tested based on ANSI/EIA-568-C

#### **B.3 Electronic Tests**

The Owner's Quality Assurance Team randomly selects cables for testing and every effort shall be made to avoid a typical testing pattern from communications cabinet to work area outlet, so that no testing pattern is discernible. The testing personnel shall inspect drops on the faceplate in multiple cases to ensure cables are labeled and no cross connects are visible, etc. The testing personnel shall perform a Q/A review of the cable termination(s) in the Communications cabinet(s) and the corresponding user location of selected cables (e.g., the faceplate labels or terminations behind the termination panel). The personnel must be consistent in testing selected cables.

The **permanent** link test configurations described in ANSI/EIA-568-C.2, performance parameters include wire map, length, Insertion loss (attenuation), NEXT, PSNEXT, ELFEXT, PSELFEXT, Return loss, Propagation delay and Delay Skew for 100 Ohm four-pair Category 5e/6 cabling. 568-C identifies acceptable ranges of test results, test equipment checks, diagnostic information, and specific test procedures.

ANSI/EIA-568-C.2, also specifies laboratory measurement methods, component and field test methods and computation algorithms over the specified frequency range. To ensure verifiable equipment calibration, the Owner's Quality Assurance Team shall certify test equipment accuracy in compliance with the ANSI/EIA568-C.2 each time a new list of tests is performed.

The Owner's Quality Assurance Team shall consider cable(s) and cabling components as pre-tested by the manufacturer to meet ANSI/EIA-568-C Category 5e/6 specifications. Therefore, individual testing of connectors and other cabling components is not required.

#### **B.4 Data Accuracy**

## *LAUSD Quality Assurance Guidelines*

Tests shall be conducted on the premise that ANSI/EIA-568-C and other applicable specifications were applied to the cable installation. Further, the Owner's Quality Assurance Team shall be provided the test result book to verify the Installer tested 100 percent of their work, so the sampling tests performed ensures system operability and customer satisfaction.

### **B.5 Data and Test Reporting**

The Quality Assurance Report shall clearly identify the test environment, test equipment used, name of each tester, acceptable results (as specified in 568-C), and actual results for each test performed. If a failure occurs, the test shall proceed, with the failure reported to the responsible Installer for repair at test end.

### **B.6 Communications Wiring Electrical Tests**

#### **B.6.1 Wire Map**

Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

#### **B.6.2 Length**

The field tester shall be capable of measuring length of pairs of a permanent link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay.

This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10 percent to allow for the variation and uncertainty of NVP.

#### **B.6.3 Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz, through the highest applicable frequency. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.

Minimum test result documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

#### **B.6.4 NEXT Loss**

## *LAUSD Quality Assurance Guidelines*

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the highest applicable frequency. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case).

**Table 1**

Frequency Range (MHz)	Maximum Step Size (MHz)
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50

NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.5 PSNEXT Loss**

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of 8 results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 MHz through the highest applicable frequency and the step size may not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.6 ELFEXT Loss, pair-to-pair**

Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute

## *LAUSD Quality Assurance Guidelines*

ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through the highest applicable frequency and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as in Table 1, column 2. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.7 PSELFEXT Loss**

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations.

Each wire-pair is evaluated from 1 MHz through the highest applicable frequency in frequency increments that do not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.8 Return Loss**

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the highest applicable frequency in increments that do not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.9 Propagation Delay**

Propagation delay is the time required for the signal to travel from one end of the link to the other.

## *LAUSD Quality Assurance Guidelines*

This measurement is to be performed for each of the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

### **B.6.10 Delay Skew**

This parameter shows the difference in propagation delay between the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pairs with the worst-case propagation Delay skew. The report shall include the Delay skew value measured as well as the test limit value.

### **B.6.11 ACR (Attenuation to crosstalk ratio)**

This parameter is not required by TIA standards but may be expected in order to obtain the premise wiring manufacturer's warranty.

ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.6.12 PSACR**

This parameter is not required by ANSI/TIA standards but may be required in order to obtain the premise wiring vendor's warranty. The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

LAUSD Quality Assurance Guidelines

## B.7 Communications Wiring Electrical Test Form

Q/A Rep(s)  
Date  
Site

Building and Communications Room Numbers

## **B.8 Electronic Tests**

The Owner's Quality Assurance Team randomly selects cables for testing and every effort shall be made to avoid a typical testing pattern from communications cabinet to work area outlet, so that no testing pattern is discernible. The testing personnel shall inspect drops on the faceplate in multiple cases to ensure cables are labeled and no cross connects are visible, etc. The testing personnel shall perform a Q/A review of the cable termination(s) in the Communications cabinet(s) and the corresponding user location of selected cables (e.g., the faceplate labels or terminations behind the termination panel). The personnel must be consistent in testing selected cables.

The **permanent** link test configurations described in ANSI/EIA-568-C, performance parameters include wire map, length, Insertion loss (attenuation), NEXT, PSNEXT, ELFEXT, PSELFEXT, Return loss, Propagation delay and Delay Skew for 100 Ohm 4-pair Category 6 cabling. 568-C identifies acceptable ranges of test results, test equipment checks, diagnostic information and specific test procedures as related to Category 6 cabling. ANSI/EIA-568-C also includes laboratory measurement methods, component and field test methods, and computation algorithms over the specified frequency range. The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in ANSI/EIA-568-C. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy *plus* adapter contribution) are specified in Table B.2 of Annex B of the ANSI/EIA-568-C standard. (Tables B.3 in this ANSI/TIA document specifies the accuracy requirements for the Channel configuration.)

The Owner's Quality Assurance Team shall consider cable(s) and cabling components as pre-tested by the manufacturer to meet ANSI/EIA-568-C Category 6 specifications. Therefore, individual testing of connectors and other cabling components is not required.

## **B.9 Data Accuracy**

Tests shall be conducted on the premise that ANSI/EIA-568-C and other applicable specifications were applied to the cable installation. Further, the Owner's Quality Assurance Team shall be provided the test result book to verify the Installer tested 100 percent of their work, so the sampling tests performed ensures system operability and customer satisfaction. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not

## ***LAUSD Quality Assurance Guidelines***

cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

### **B.10 Data and Test Reporting**

The Quality Assurance Report shall clearly identify the test environment, test equipment used, name of each tester, acceptable results (as specified in 568-C Category 6 related), and actual results for each test performed. If a failure occurs, the test shall proceed, with the failure reported to the responsible Installer for repair at test end.

### **B.11 Communications Wiring Electrical Tests**

The test parameters for Category 5e and Category 6 are defined in ANSI/EIA-568-C standard. The test of each link shall contain the following parameters as detailed below. In order to pass the test, measurements (at each frequency in the range from 1 MHz through 350 MHz) must meet or exceed the limit value determined in the above-mentioned standard.

#### **B.11.1 Wire Map**

Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

#### **B.11.2 Length**

The field tester shall be capable of measuring length of pairs of a permanent link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation. The physical length of the link shall be calculated using the pair with the shortest electrical delay.

This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10 percent to allow for the variation and uncertainty of NVP.

#### **B.11.3 Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz, through the highest applicable frequency. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.

Minimum test result documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the

## *LAUSD Quality Assurance Guidelines*

highest attenuation value measured (worst case), the frequency at which this worst case value occurs and the test limit value at this frequency.

### **B.11.4 NEXT Loss**

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the highest applicable frequency. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case).

**Table 2**

Frequency Range (MHz)	Maximum Step Size (MHz)
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50
250-350	1.00

NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.11.5 PSNEXT Loss**

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of eight results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 MHz through the highest applicable frequency and the step size may not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.11.6 ELFEXT Loss, pair-to-pair**

Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through the highest applicable frequency and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.11.7 PSELFEXT Loss**

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations.

Each wire-pair is evaluated from 1 MHz through the highest applicable frequency in frequency increments that do not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.11.8 Return Loss**

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the highest applicable frequency in increments that do not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests

## *LAUSD Quality Assurance Guidelines*

performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.11.9 Propagation Delay**

Propagation delay is the time required for the signal to travel from one end of the link to the other.

This measurement is to be performed for each of the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

### **B.11.10 Delay Skew**

As defined in ANSI/EIA-568-C.2, this parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero.

Minimum test result documentation (summary results): Identify the wire pairs with the worst-case propagation Delay skew. The report shall include the Delay skew value measured as well as the test limit value.

### **B.11.11 ACR (Attenuation to crosstalk ratio)**

This parameter is not required by TIA standards but may be expected in order to obtain the premise wiring manufacturer's warranty.

ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

### **B.11.12 PSACR**

The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed

***LAUSD Quality Assurance Guidelines***

from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

LAUSD Quality Assurance Guidelines

## B.12 Communications Wiring Electrical Test Form

Site

Date

Q/A Rep(s)

Building and Communications Room Numbers

## **APPENDIX C - FIBER OPTIC CABLE PERFORMANCE TESTS**

### **C.1 Overview of Cable Tests**

ANSI/EIA-568-C states, “The optical fiber cable construction shall consist of 50/125 mm or 62.5/125 mm multimode optical fibers or singlemode optical fibers, or a combination of these media.” Multimode fiber shall have a graded-index optical fiber waveguide with nominal 50/125  $\mu\text{m}$  for installations following specification 27 1014, or 62.5/125  $\mu\text{m}$  core/ cladding diameter for installations following specification 27 1013. Primary and secondary backbone cable testing shall be equivalent to backbone cabling as defined in ANSI/EIA-568-C, such as cabling interconnecting telecommunications closets, equipment cabinets, and entrance facilities. Therefore, the Owner’s Quality Assurance Team shall perform the following interrelated tests:

1. Verification of multi-mode fiber optic cable installations.
2. Verification of single-mode fiber optic cable installations.
3. Electronic measurement of the distance and equivalent attenuation per kilometer (km) to verify minimum data transmission capacity per specification.
4. Total link attenuation measurements.

### **C.2 Test Equipment**

The following test equipment shall be used:

1. Fluke DSP 1800, tester with copper single mode and multi-mode power meter and light source heads or equal
2. Fluke, DTX 1800, OptiFiber Optical Time Domain Reflectometer (OTDR) Module, or equal.

#### **C.2.1 Cabling Distance**

The combined primary (450m) and secondary (10m) backbone multimode fiber strands shall primarily be utilized by the network electronics up to 550 meters and testing shall conform to OFSTP-14A. The Singlemode strands shall be required where cabling the backbone distance exceeds 550 meters and testing shall conform to OFSTP-7.

### **C.3 Test Procedures**

For multi-mode fiber the Owner’s Quality Assurance Team shall use the Fluke DTX 1800 to test the length and total attenuation at both the 850 nm and 1300 nm wavelengths in each direction (bi-directionally). If the test fails, the Owner’s Quality Assurance Team may request a repeat test using the OTDR to assess the failure point and address corrective actions. (See Methods A and B attached.)

## ***LAUSD Quality Assurance Guidelines***

For single-mode fiber, the Owner's Quality Assurance Team shall use a Fluke DTX 1800 with single mode test heads. The specific nanometer wavelength(s) at which the single-mode fiber shall be tested (i.e., 1310 nm and/or 1550 nm) shall be determined based on the length of the fiber cable being tested.

### **C.3.1 Cable Distance**

Using the Fluke DTX 1800, the Owner's Quality Assurance Team shall determine the overall fiber optic cable length to ensure the cabling distance is within the maximum allowable length.

### **C.3.2 Attenuation**

ANSI/EIA-568-C, indicates that components compliant with this standard, the single performance parameter necessary for performance testing is link attenuation. The backbone optical fiber cabling link segment should be tested in one direction at both operating wavelengths, to account for attenuation deltas associated with wavelength.

The Owner's Quality Assurance Team shall use the Fluke 1800 or OTDR to measure the attenuation due to fiber optic cable and connectors. The Owner's Quality Assurance Team shall test and record attenuation at both 850nm/1300nm for each Multi-mode and 1310nm/1550nm for Single-mode fiber optic strand respectively terminated under this initiative. These tests shall be performed at each communications cabinet and from the MDF cabinet, as required.

### **C.3.3 Information Transmission Capacity**

The fiber optic cable is assumed to be within the allowable attenuation per kilometer as specified in ANSI/EIA-568-C.3. The Owner's Quality Assurance Team shall presume the transmission capacity of the cable is within specification.

## **C.4 Data Reporting and Accuracy**

The Owner's Quality Assurance Team shall report loss measurement results, with locations and wavelength identifications, to the Owner in accordance with EIA/TIA OFSTP-14 and OFSTP-7. The contractor shall provide copies of the test results in native format to the Owner's Quality Assurance team at the conclusion of the structured cabling testing or any time during the testing process.

*LAUSD Quality Assurance Guidelines*

**C.4.1 Fiber Optic Cable Installation Test Form— Fluke DTX 1800 and OTDR**

Site \_\_\_\_\_ Q/A \_\_\_\_\_ Review Form:  
Rep(s) \_\_\_\_\_ Date \_\_\_\_\_ Pass / Fail

Fluke DTX 1800 \_\_\_\_\_ Fluke DTX 1800 \_\_\_\_\_ Distant End  
Serial #: \_\_\_\_\_ Location \_\_\_\_\_ Location \_\_\_\_\_

OTDR \_\_\_\_\_ Near End TFBM \_\_\_\_\_ Distant End  
Serial #: \_\_\_\_\_ Serial #: \_\_\_\_\_ TFBM Serial #: \_\_\_\_\_

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓		Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓
850	1-blue						850	13-blue		
1300							1300			
850	2-orange						850	14-orange		
1300							1300			
850	3-green						850	15-green		
1300							1300			
850	4-brown						850	16-brown		
1300							1300			
850	5-slate						850	17-slate		
1300							1300			
850	6-white						850	18-white		
1300							1300			
850	7-red						850	19-red		
1300							1300			
850	8-black						850	20-black		
1300							1300			
850	9-yellow						850	21-yellow		
1300							1300			
850	10-violet						850	22-violet		
1300							1300			
850	11-rose						850	23-rose		
1300							1300			

**LAUSD Quality Assurance Guidelines**

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓		Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓
850	12-aqua						850	24-aqua		
1300							1300			

**C.4.2 Fiber Optic Cable Installation Test Form—Power Meter and Light Source**

Site \_\_\_\_\_ Q/A Rep(s) \_\_\_\_\_ Date \_\_\_\_\_ Q/A Review Form:  
Pass / Fail

Power Meter  
Serial #: \_\_\_\_\_ Power Meter Location \_\_\_\_\_

Light Source  
Serial #: \_\_\_\_\_ Light Source Location \_\_\_\_\_

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓		Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓		Disk	Comments
1310	1-blue						1310	13-blue					
1550							1550						
1310	2-orange						1310	14-orange					
1550							1550						
1310	3-green						1310	15-green					
1550							1550						
1310	4-brown						1310	16-brown					
1550							1550						
1310	5-slate						1310	17-slate					
1550							1550						
1310	6-white						1310	18-white					
1550							1550						
1310	7-red						1310	19-red					

*LAUSD Quality Assurance Guidelines*

Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments	Wave-length (nm)	Strand	Length (m)	Total Attn (dB) ↑↓	Disk	Comments
1550						1550					
1310	8- black					1310	20- black				
1550						1550					
1310	9- yellow					1310	21- yellow				
1550						1550					
1310	10- violet					1310	22- violet				
1550						1550					
1310	11- rose					1310	23- rose				
1550						1550					
1310	12- aqua					1310	24- aqua				
1550						1550					

## **APPENDIX D - NETWORK EQUIPMENT PERFORMANCE TESTS**

### **D.1 Overview of Equipment Tests**

These equipment tests verify the operation of the network components (e.g., switches, and routers) either purchased or provided for use as part of the particular project. This plan addresses industry-standard TCP/IP tests that collectively address Network layer connectivity and IP packet path routing; it does not address network performance (i.e., total throughput capabilities) tests.

The Owner's Quality Assurance Team shall perform the following interrelated tests:

1. Spanning Tree Root Bridge identification test. Spanning tree protocol is one of the most important layer two protocols at work in switches. Spanning Tree ensures that no loops occur in a network by a designated root bridge. The root bridge is a central point of a spanning-tree configuration and it controls how the protocol operates. It is best practice to configure the core switch to be the root bridge. Run the following command on the core switch to identify it is set as the root bridge: Show spanning-tree summary.
2. Internet Control and Message Protocol (ICMP) Ping Test. This test verifies the Network layer for connectivity by using Ether-type frame pings to reach IP target addresses and obtain or verify four results—the target IP address, the local media access control (MAC), the number of responses, and the response time. The target IP addresses are the upstream and/or downstream gateway IP addresses based on the device's connectivity in the network. The source is the management console on the device. Each test includes two steps, if necessary, as follows:
  - a. Obtain the four results by performing an address resolution protocol (ARP) for the target IP address and verifying the ping.
  - b. If test 1 is unsuccessful, obtain the four results by executing an ARP for the default router, then use the acquired MAC address to determine the IP address, send an ICMP echo request and monitor for the ICMP reply.
3. Trace Route/Path Discover. This test determines the path IP packets follow, and reports each router encountered in the path. Testing elicits an ICMP TIME-EXCEEDED response from each router encountered. Each hop is tested three times to help identify changing routes.
4. Configuration Test. This test verifies that each new network port is operational. Perform an ICMP ping from each port not previously tested, ensuring each port has a link light indicating port operability.

## *LAUSD Quality Assurance Guidelines*

5. VLAN configuration verification. Inspect VLAN configuration and port assignments to be matching the provided documentation. Inspect VLAN trunking, and verify forwarding state of required VLANs on VLAN trunks.

### **D.2 Test Equipment**

The following test equipment shall be used:

1. Fluke 685 Enterprise LAN Meter or equivalent.
2. Computer with TCP/IP protocol stack, TELNET application and data capture software (optional).

### **D.3 Test Methodology**

The basic test methodology is to verify connectivity from user access ports through and within the installed intra-network to the WAN Router. Overall connectivity is verified by testing to and from points in the network. Site testing reflects the specific switch(s) and router(s) implemented at the site.

### **D.4 Test Hierarchy for Connectivity (Pings, Trace Routes and Telnets)**

Table D.4-1 contains the network equipment performance tests and corresponding descriptions.

**Table D.4-1. Network Equipment Performance Tests**

TEST	TEST DESCRIPTION
Ping from Wall outlet WAN or Internet location	Connect the computer into the network via the wall plate, obtain DHCP IP address and perform a ping to a known IP address or URL outside the campus network.

### **D.5 Network Equipment Configuration Verification and Performance Tests**

The Owner's Quality Assurance Team shall follow the test sequence shown. The following sample form lists tests to be performed at this site. For the set of Network Equipment Performance Test forms tailored to the individual communications cabinets, please see enclosed file Network Checklists.doc.

#### **D.5.1 Network Equipment Configuration Verification Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_  
Building and Communications Cabinet Numbers \_\_\_\_\_  
\_\_\_\_\_

*LAUSD Quality Assurance Guidelines*

Device Name/IP	Type of device	Type of Configuration verified	PASS	FAIL
	Ethernet Switch	VLAN / STP/ port activation/Trunking		
	Ethernet Switch	VLAN / STP/ port activation/Trunking		
	Router/ L3 switch	IP Routing/ SNMP/ Access-lists		
	Router/ L3 switch	IP Routing/ SNMP/ Access-lists		

**D.5.2 Network Equipment Performance Test Form**

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_

Building and Communications Cabinet Numbers \_\_\_\_\_

(a packet loss in excess of 1 percent during ping test is not acceptable and is considered a FAIL)

TEST	SOURCE ADDRESS/LOCATION	DESTINATION ADDRESS/LOCATION	PASS	FAIL
Ping from Wall outlet to WAN Router location				
Trace route from Wall outlet to WAN Router location				

*LAUSD Quality Assurance Guidelines*

**APPENDIX E - PHYSICAL CONFIGURATION AUDIT**

**E.1 Overview of Physical Connectivity Audit**

A Physical Connectivity Audit is completed comparing the vendor supplied Equipment Inventory List (EIL) against the Cabinet Equipment Survey generated by the test team at Quality Assurance. This appendix provides the detailed audit of the physical equipment and materials installed under this expansion effort.

**E.2 Physical Connectivity Audit Quality Assurance Review lists**

The following sample form shows the general information to be documented for a standard Cabinet Equipment Survey.

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_

Building and Communications Cabinet Numbers \_\_\_\_\_

Location	Location Annotation	Number of Switches	Number / Type of UPS	Number of Fibers (MM/SM)	Number of Horiz. Copper drops	Number of Horiz. Fibers
MDF						
IDF1						
IDF2						
IDF3						
IDF4						
IDF5						
IDF6						
IDF7						
LDF1						
LDF2						
LDF3						
LDF4						
Notes:						

*LAUSD Quality Assurance Guidelines*

**APPENDIX F - CABLE DOCUMENTATION SPECIFICATION**

**F.1 Documentation.**

- F.1.1** The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
- F.1.2** Individual test reports shall be submitted in hardcopy and electronic format. Hand-written test reports are not acceptable.
- F.1.3** The test results records saved by the tester in .flw format shall be kept in .flw format for opening at anytime with Fluke Networks LinkWare software, version 6 or newer. It may also be transferred into, an excel spreadsheet, pdf, or zipped in a .RAR file that allows for the maintenance, review and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
- F.1.4** Hardcopy reports may be submitted in labeled three ring binders with an attached affidavit verifying passing execution of tests. For large installations electronic reports with hardcopy summaries are preferred. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, length, and date of test and pass/fail result.
- F.1.5** Electronic reports are to be submitted in CD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., then software to read these files is not needed. Electronic reports must be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
- F.1.6** Test reports shall include the test measurement information specified in Section 5 for each cabling element tested, in addition to:
- F.1.7** Cable manufacturer, cable model number/type and NVP.
- F.1.8** Tester manufacturer, model, serial number, hardware version and software Ver.
- F.1.9** Circuit ID number.
- F.1.10** Auto test specification used.
- F.1.11** Identification of the tester interface.
- F.1.12** Overall pass/fail indication.
- F.1.13** Date and time of test.

***LAUSD Quality Assurance Guidelines***

**Table F.2 Cable Test Parameter Preferences**

When reading the printed test result output, the following parameters must be shown with the associated cable test.

Cable Testing Parameter Preferences								
Cable Test	NVP	Cable	Auto test	Fiber Type	GRI	Reference	Test Direction	Pulse Width
Level (IIE) Category 5 E Tester	69 – 72	Cat 5E	Cat 5E Perm link	n/a	n/a	n/a	n/a	n/a
Level (III) Category 6 Tester	69 – 72	Cat 6	Cat 6 Perm link	n/a	n/a	n/a	n/a	n/a
Power Meter Horizontal MM F/O @ 850nm/1300nm	n/a	62.5/125 Mnfr	568B Horizontal	Multimode 50 or 62.5	1.4920 @ 1300nm	1 jumper method	Bi- Directional	n/a
Power Meter Backbone MM F/O @ 850nm/1300nm	n/a	62.5/125 Mnfr	568B Backbone	Multimode 50 or 62.5	1.4920 @ 1300nm	1 jumper method	Bi- Directional	n/a
Power Meter Backbone SM F/O @ 1310nm/1550nm	n/a	SM Mnfr	1000 Base -LX	Single Mode	1.4640 @1300nm	1 jumper method	Bi- Directional	n/a
OTDR Horizontal MM F/O @ 850nm/1300nm	n/a	n/a	n/a	Single Mode	n/a	n/a	Uni- Directional	<50ns
OTDR Backbone MM F/O @ 850nm/1300nm	n/a	n/a	n/a	Single Mode	n/a	n/a	Uni- Directional	<50ns
OTDR Backbone SM F/O @ 1310nm/1550nm	n/a	n/a	n/a	Single Mode	n/a	n/a	Uni- Directional	<50ns

NOTE: The length of the cable is the variable of which the Power Meter and light source determines the expected dB loss for Backbone cable tests.

*LAUSD Quality Assurance Guidelines*

**Table F.3 Allowable Distance per Fiber Length**

Use this table as a guideline to compare references for dB loss in the installed Backbone Fiber. Total loss includes .75 dB loss per mated connector pair.

Fiber Cable Distance	Multimode dB Loss	Singlemode dB Loss	Fiber Cable Distance	Multimode dB Loss	Singlemode dB Loss
100'	1.6	1.53	1200'	2.7	1.86
200'	1.7	1.56	1300'	2.8	1.89
300'	1.8	1.59	1400'	2.9	1.92
400'	1.9	1.62	1500'	3.0	1.95
500'	2.0	1.65	1600'	3.1	1.98
600'	2.1	1.68	1700'	3.2	2.01
700'	2.2	1.71	1800'	3.3	2.04
800'	2.3	1.74	1900'	3.4	2.07
900'	2.4	1.77	2000'	3.5	2.10
1000'	2.5	1.80	2100'	3.6	2.13
1100'	2.6	1.83	2200'	3.7	2.16

END OF APPENDICES

## SECTION 27 0127

**QUALITY ASSURANCE, TEST & ACCEPTANCE REQUIREMENTS  
NEW AND EXISTING FACILITIES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

A. Principal items of work in this section include but are not limited to:

1. Ensure all quality assurance, testing and final acceptance requirements for all premises cabling and wireless network installations comply with industry standards and Project Construction Documents.
2. The Los Angeles Unified School District (OWNER) seeks to improve the quality of its network installations. In order to achieve this objective, the guidelines specified below are to serve as a technical reference for the Owner's infrastructure verification and acceptance of the CONTRACTOR's testing. The appendix of this section describes specific test procedures that the Owner shall observe during the acceptance testing, particularly those involving LAN, Convergence and WLAN equipment, and associated cable plants. The procedures provide a comprehensive series of visual, electronic, and optical tests to ensure the infrastructure installation complies with the standards set forth in the specifications. The successful culmination of these tests shall be used to document a physical configuration audit (PCA) as part of the Owner's Quality Assurance (Q/A) Report. Testing shall include physical Q/A review of installation and performance testing of all components.

B. Responsibilities for this specification are as follows:

1. The CONTRACTOR shall follow ANSI/TIA and BICSI installation standards. The CONTRACTOR shall perform all Category 5e/ 6 (UTP) horizontal cable installation, labeling, and terminations in the communications cabinets and at each work area outlet. The CONTRACTOR shall perform all primary fiber optic backbone and secondary fiber optic backbone cable installation, labeling and terminations in the communications cabinets.
  - a. During installation the CONTRACTOR shall perform tests as required by the Parent Specification and in compliance with testing standards found in Appendixes B, C, & D of this Section.

- b. Prior to the start of the Quality Assurance walk with the Owner, the CONTRACTOR shall submit electronic copies of all test results, documentation, asset lists, and work books to the ITIPMO. The test results are to be in native format of the test unit. Up to date, clearly legible and accurate cable charts shall be submitted along with the test results.
  - c. Upon acceptance by the Owner of the CONTRACTOR's documentation, the CONTRACTOR will submit a written request (see Form 425 at the end of this specification) a minimum of 48 hours prior to the start of the QA process. The ITIPMO shall schedule the Owner's Quality Assurance Review, after acceptance of the CONTRACTOR's 48 Hour Notice. Upon completion of the Quality Assurance walk with the owner the final systems test may be authorized by the Owner provided all functional punch list items have been resolved.
2. CONTRACTOR's Site Responsibilities during formal Owner's Quality Assurance Review and Final Testing: During the formal Owner's Quality Assurance Review, the CONTRACTOR shall comply with testing standards and requirements detailed in Appendices A through E. Under the guidance of the Owner's Quality Assurance Team, the CONTRACTOR shall:
    - a. Verify LAN/WLAN connectivity and WAN extension cabling to MDF.
    - b. Verify that the configuration of the router, switches, wireless access points, and the wireless controller is in compliance with the Contract Documents.
    - c. Provide labor, materials, and testing equipment (e.g., cable testers with multimode, single and copper test heads, OTDR) to correct any deficiencies with labeling, redlines, cable charts, and terminations.
    - d. Provide labor, materials, and testing equipment (e.g. laptop loaded with wireless analysis software) to correct any deficiencies with wireless coverage and throughput.
    - e. Provide keys and access to all installed network equipment.
  3. Owner's Quality Assurance Team Responsibilities: the Owner's Quality Assurance Team shall verify that the infrastructure installed under the Contract complies with the installation standards detailed in the Specifications. Specifically, testing shall be performed by the

CONTRACTOR in the presence of the Owner's Quality Assurance Team on vertical and horizontal cable (e.g., fiber optic, Category 5e/ 6 UTP ) along with component installations performed under the scope of the overall infrastructure effort (e.g., Ethernet switches, Wireless Access Points, Controllers, and routers). Generally, testing specifications and procedures cover the following:

- a. Q/A review and validation of equipment rack installation, including placement in the communications cabinets, attachment to the floor, and seismic bracing.
- b. Q/A review and validation of fiber terminations, patch panel installation, cable labeling, and cable bundling.
- c. Q/A review of Category 5e/6, T568B terminations, including cable end connections at the patch panel and work area outlets.
- d. Q/A review of the CONTRACTOR's Redlines for accuracy.
- e. Industry standard for fiber optic, Category 5e and Category 6 cable performance testing.
- f. Network equipment performance verification.
- g. Uninterruptible power supply performance verification.
- h. Communications cabinet layout and facility drop count verification.
- i. Wireless Local Area Network performance verification

## 1.02 RELATED SECTIONS

- A. Applicable Division 1 sections
- B. Section 00 7000: General Conditions
- C. Section 01 7700: Contract Closeout
- D. Section 06 1000: Rough Carpentry
- E. Section 21 2323: Excavating, Backfilling and Compacting for Utilities
- F. Section 26 0500: Common Works Results for Electrical
- G. Section 26 0513: Basic Electrical Materials and Methods.

- H. Section 26 0526: Grounding and Bonding
- I. Section 26 0533: Raceways and Boxes Fittings and Supports.
- J. Section 26 2416: Panelboards and Signal Terminal Cabinets
- K. Section 27 0127: Quality Assurance, Test, & Acceptance Requirements
- L. Section 27 1015: Premises Wiring for Convergence of Communication Systems
- M. Section 27 1017: Wireless Local Area Network (WLAN)
- N. Section 27 1018: Local Area Network (LAN) Systems for Instructional Locations and Small/Medium Office Locations
- O. Section 27 3100: Converged IP Telecommunication Systems
- P. Section 27 5127: Public Address Systems (Small Gyms and Multipurpose Rooms)

#### 1.03 REFERENCES

- A. ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
- B. ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard, current issue
- C. ANSI/TIA-568-C.2 Balance Twisted-Pair Telecommunications Cabling and Components Standards
- D. ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standards
- E. ANSI/TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling
- F. EIA/TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces and all current addenda
- G. ANSI/EIA/TIA-598-A, Optical Fiber Cable Color Coding, current issue
- H. EIA/TIA-606A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- I. ANSI-J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications.
- J. EIA/TIA-OFSTP-14A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

- K. ANSI/TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard, current issue in accordance with TIA TR-42.4
- L. EIA/TIA-OFSTP-7, Optical Power Loss Measurements of Installed Single mode Fiber Cable Plant
- M. American National Standards Institute (ANSI)/EIA/TIA-455-59, Field Testing
- N. FCC Part 68
- O. National Electrical Manufacturer's Association (NEMA)
- P. National Fire Protection Association (NFPA), NFPA-70
- Q. CCR Part 3 - California Electrical Code (CEC)
- R. CCR Part 2 - Uniform Building Code (UBC)
- S. Building Industry Consulting Services International (BICSI) TDMM, most recent revision
- T. Institute of Electrical and Electronic Engineers (IEEE)
- U. Other Codes and Standards as defined in the Parent Specification

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT INSTALLATION

- A. The CONTRACTOR is responsible for installation and cross connection of all LAN equipment required by the Contract Documents. The Owner's Quality Assurance Team shall verify that the installation is complete, functional and installed according the CONTRACTOR's drawings.

### 2.02 PUNCH LIST

- A. The Owner's Quality Assurance Team shall review the CONTRACTOR's installation and generate a Punch List for IT and low voltage systems. The Punch List will be provided to the CONTRACTOR via the IT Project Management Office.

### 2.03 QUALITY ASSURANCE

- A. Owner's Quality Assurance Test Schedule:

1. The ITIPMO shall schedule the Owner's Quality Assurance test after review of the CONTRACTOR's complete Test Results of the school.

**PART 3 - EXECUTION – Not Used**

**END OF SECTION**

## APPENDIX A - QUALITY ASSURANCE PROCEDURES

### A.1 Overview of Quality Testing Procedures

This appendix provides guidelines for Quality Assurance reviews of each site. The Owner's Quality Assurance Team shall examine the work based upon the guidelines outlined in the following appendixes and their associated forms.

1. Communications Cabinet Review. Verify the design and compliance with contract documents. This may include: ANSI/TIA and BICSI cabling practices, standard and specific labeling practices, and safe and logical equipment and wire management placement.
2. Cable Plant Review. Cabling from the Communications cabinet, at various points along the cable path, and in functional work areas for compliance with ANSI/TIA installation specifications including ANSI/TIA-568-C and TIA/EIA-569A and all documents referenced therein and professional installation practices.
3. User Work Area Quality Assurance Review. Cabling at the user wall plate location in the functional work areas for compliance with ANSI/TIA installation specifications including ANSI/TIA-568-C and TIA/EIA-569-A and all documents referenced therein and professional installation practices.
4. Redline As-Built Documentation shall be compared to physical installation. Deviations shall be noted and the Quality Assurance procedure halted until discrepancies have been rectified at CONTRACTOR's expense.
5. Hard copies (ARCH D 24" x 36") of up to date and current Logical Network Diagrams (LND) Documentation shall be compared to physical installation. Deviations shall be noted and the Quality Assurance procedure halted until discrepancies have been rectified at CONTRACTOR's expense.
6. Electronic workbook documentation (both hard copies and soft copies) shall be compared to physical inventory of all installed electronics. Deviations shall be noted and the Quality Assurance procedure halted until discrepancies have been rectified at CONTRACTOR's expense.
7. Hard copies (ARCH D 24" x 36") of up to date and current campus wide wireless Access Point location maps must be provided at the time of the Owner's quality assurance walk. The CONTRACTOR must provide clear and legible Access Point location maps for each floor on campus. The maps must indicate AP placements, AP designations, AP types, antenna types, altitude and azimuth as needed and any other pertinent wireless information. Deviations

shall be noted and the Quality Assurance procedure may be halted until discrepancies have been rectified at CONTRACTOR's expense.

#### A.2 General Quality Assurance Guidelines

The Owner's Quality Assurance Team visually reviews the installation to verify that all cabling is supported properly. No cable shall have been installed in pathways near sharp edges or objects that might cause damage. Cable shall not be supported by, on, or attached to a dry wall ceiling, ceiling tiles, ceiling grid, routed over pipes, conduit, lighting fixtures, or other wiring. The Owner's Quality Assurance Team should be able to determine the total number of drops dispersed from each communications cabinet, the number of drops for each supported room, and the agreed-upon labeling scheme for the site. The CONTRACTOR shall have met the following general labeling guidelines:

Clearly labeled each drop number and Communications cabinet on the wall jack faceplate using a permanent label.

Label each horizontal cable jacket using a permanent label at the workstation end, inside the wall, and the patch panel end no more than two inches from each end.

At workstation end: communications cabinet, drop, and termination panel.

At patch panel end: drop and cabinet numbers.

Label each patch panel port with drop number and cabinet number.

Because work area room numbers may have been modified since the design, the CONTRACTOR shall provide as-built documentation for each communications cabinet, reflecting the room numbers used in the labeling scheme as a reference point. The CONTRACTOR and their SubCONTRACTOR shall use these working prints to produce post-installation as-built drawings.

#### A.3 Deficiency Reports

Before beginning any test, the Owner's Quality Assurance Team shall view any deficiency report(s) (DR). The Owner's Quality Assurance Team shall review the DR(s) as part of the Quality Assurance review to ensure the required corrective actions have been taken.

#### A.4 Quality Assurance Test Procedures

The Owner's Quality Assurance Team shall follow the acceptance test and performance criteria outlined in ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, ANSI/TIA-1152, OFSTP-14A, and OFSTP-7 and shall conduct acceptance and performance testing following each manufacturer's specification on their respective network components to verify compliance with manufacturer's installation instructions.

#### A.5 Construction Quality Assurance of Work:

During the installation of low voltage systems, the Owner's Quality Assurance Team shall examine the following:

1. General to all Low Voltage Systems:
  - a. All conduit and raceway layout and installation for each low voltage system and verify that they meet all project specifications.
  - b. Equipment rack installation, including placement in the communications room, seismic bracing, and attachment to the floor.
  - c. Cable punch-downs, patch panel installation, cable cross-connection, cable labeling, and cable bundling.
  - d. Verify proper equipment installation, cable cross connection, system configuration, and testing.
  - e. Verify all system layout and device location(s) match the locations shown on the as-builds.
  - f. All active components, terminal cabinets, cross connects, splices, etc. are located in a secure interior location.
  - g. Verification of Uninterruptible Power Supply, UPS, performance.
  - h. Verification of proper air conditioning in all MDF and IDFs. Room temperature should maintain between 65 - 72 degrees 7 days per week, 24 hours per day.
2. LAN, verify the following:
  - a. Examine Category 5e/ 6, T568B terminations, including cable end connections at the patch panel and wall drop receptacles.
  - b. Examine fiber terminations and fiber termination boxes.
  - c. Examine CONTRACTOR's basic network components installation and operation.
  - d. Review customized configuration and test results.
  - e. Test overall network operation to ensure it meets Owner's strategic planning and acceptable performance level.

## A.6 Test Procedures

1. Q/A Review

- a. The Owner's Quality Assurance Team shall conduct a review of the installation including the communication cabinet, cable runs, and user work areas. Appendix A documents these Q/A review procedures.

2. Cable Performance Testing

- a. The CONTRACTOR's Quality Assurance Team shall test only the fiber optic Backbone cable specified for use by the design plus one identified spare pair, a random sample of Category 5e/ 6 UTP cable and the fiber optic secondary backbone cable. Appendix C outlines these specific tests.
  - (1) Test Cable Sampling: The Owner's Quality Assurance Team shall randomly select 10% of installed horizontal cables from each communication cabinet on site for testing. For example, if a communications cabinet has 100 drops, the CONTRACTOR's Quality Assurance Team shall test a minimum of 10 drops for each cabinet. Where random testing shows a failure rate of more than 1% of the drops (2 in 10 of the random sample), an additional 10% of the installed horizontal cabling shall be tested. Appendix B outlines these specific tests. The owner reserves the right have more than 10% tested on a case by case basis.
  - (2) Cable Testing: The CONTRACTOR's Quality Assurance Team shall perform industry-standard operational and performance cable testing detailed in ANSI/TIA-568-C.2 and ANSI/TIA-568-C in the presence of the Owner's Quality Assurance Team.

3. Network Equipment Testing

- a. The Owner's Quality Assurance Team shall perform network tests on all hardware components for proper installation, per manufacturer's recommendations and configuration. All components shall be tested separately for initial power up and their ability to maintain system configuration.

4. Wireless Access Point and Wireless Controller Testing

- a. The Owner's Quality Assurance Team and the CONTRACTOR's Quality Assurance shall participate in the test of the CONTRACTOR's installed system as set forth in OWNER specification 25810.

## A.7 Acceptance Criteria

1. An overall Pass or Fail condition shall be determined by the results of the required individual test. Any Fail and Fail\* shall result in an overall Fail. In

order to achieve an overall Pass condition, all individual results shall be Pass or Pass\*. A Pass or Fail result for each parameter is determined by the allowable limits for that parameter. The test result of a parameter is marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer shall provide documentation as an aid to interpret results marked with asterisks.

2. Cable plant acceptance by the Owner requires 100% passing results for all cable samples and corrected cabling deficiencies. Acceptance of other components is based upon satisfactory completion of a test configuration scenario, as defined in the appropriate appendix to this plan.

#### **A.8 Corrective Procedures**

1. ANSI/TIA testing specification details a pass/fail criterion, i.e., if a fiber optic cable is outside of specifications, the test fails. The Owner's Quality Assurance Team shall identify any deficiencies found during Quality Assurance (e.g., a cable or component failing a test) to site personnel before the Owner's Quality Assurance Teams departure and shall document these deficiencies in the Quality Assurance Report. If the link attenuation for any fiber optic cable strand is outside acceptable loss as specified in ANSI/TIA-568-C, the CONTRACTOR shall re-complete the terminations required to reduce the amount of attenuation. If re-termination fails, the CONTRACTOR shall be required to take steps up to and including the replacement of the cable to eliminate the testing deficiency. After corrective action, the Owner's Quality Assurance Team shall retest all repaired fiber runs and document the results in the Quality Assurance Report.
2. The CONTRACTORS' Quality Assurance Team shall identify any deviation from acceptable ANSI/TIA specifications for cabling resulting in a test failure.

#### **A.9 Quality Assurance Reporting**

1. Acceptance Recommendation
  - a. At the conclusion of testing, the Owner's Quality Assurance Team shall provide a recommendation to the IT-PMO to accept or not accept the installation.

#### **A.10 Test Equipment**

1. The CONTRACTOR shall provide a test team at the time of final testing. The test team shall use the following test equipment or their equivalent during testing.
  - a. Fluke DTX-1800 or DSX-5000 Level V tester with single-mode and multi-mode power meter and light source heads. All test equipment shall be calibrated as required by the manufacturer..

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- b. The CONTRACTOR will provide a computer running as an FTP or Iperf (with Jperf as the graphical user interface) server with a Gigabit Ethernet port.
- c. The CONTRACTOR will have an ITIPMO approved wireless network test tool running on their laptop that monitors and analyzes the wireless traffic and throughput. For consistency, it is highly recommended that the same type of wireless NIC be used throughout the project.
- d. Thermometer

## **APPENDIX B - CATEGORY 5E AND CATEGORY 6 UTP CABLE PERFORMANCE TESTS**

### **B.1 Overview of Cable Tests**

This appendix provides guidelines for electronic testing of Horizontal Category 5e / 6 UTP wiring. The Owner's Quality Assurance Team shall meet the guidelines outlined in the following Q/A review and its associated forms.

**Electronic Testing.** This testing verifies that the standard performance parameters for the UTP cable as outlined in ANSI/TIA-568-C.2 are within the specifications as noted below. Refer to Premise Wiring Specification.

### **B.2 Test and Support Equipment**

1. The types of cable to be tested are as follows :
  - a. Category 5E/ 6 UTP shall be tested based on ANSI/TIA-568-C.2

### **B.3 Electronic Tests**

The Owner's Quality Assurance Team randomly selects cables for testing and every effort shall be made to avoid a typical testing pattern from communications cabinet to work area outlet, so that no testing pattern is discernible. The testing personnel shall inspect all drops on the faceplate in multiple cases to ensure all cables are labeled and no cross connects are visible, etc. The testing personnel shall perform a Q/A review of the cable termination(s) in the Communications cabinet(s) and the corresponding user location of selected cables (e.g., the faceplate labels or terminations behind the termination panel). The personnel must be consistent in testing selected cables.

The **permanent** link test configurations described in ANSI/TIA-568-C.2 performance parameters include wire map, length, Insertion loss (attenuation), NEXT, PSNEXT, ELFEXT, PSELFEXT, Return loss, Propagation delay and Delay Skew for 100 W 4-pair Category 5e / 6 cabling. ANSI/TIA 568-C.2 identifies acceptable ranges of test results, test equipment checks, diagnostic information, and specific test procedures.

TIA-1152 also specifies laboratory measurement methods, component and field test methods and computation algorithms over the specified frequency range. To ensure verifiable equipment calibration, the Owner's Quality Assurance Team shall certify test equipment accuracy in compliance with TIA-1152 each time a new list of tests is performed.

### **B.4 Data Accuracy**

Tests shall be conducted on the premise that ANSI/TIA -568-C.2 and other applicable specifications were applied to the cable installation. Further, the Owner's Quality Assurance Team shall be provided the test result book to verify the CONTRACTOR tested 100 percent of their work, so the sampling tests performed ensures system operability and customer satisfaction.

## **B.5 Data and Test Reporting**

The Quality Assurance Report shall clearly identify the test environment, test equipment used, name of each tester, acceptable results (as specified in ANSI/TIA-568-C.2), and actual results for each test performed. If a failure occurs, the test shall proceed, with the failure reported to the responsible CONTRACTOR for repair at test end.

## **B.6 Communications Wiring Electrical Tests**

### **B.6.1 Wire Map**

Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

### **B.6.2 Length**

The field tester shall be capable of measuring length of all pairs of a permanent link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay.

This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

### **B.6.3 Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz, through the highest applicable frequency. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.

Minimum test result documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

### **B.6.4 NEXT Loss**

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the highest applicable frequency. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on

the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case).

**Table 1**

Frequency (MHz)	Range	Maximum Step Size (MHz)
1 – 31.25		0.15
31.26 – 100		0.25
100 – 250		0.50

NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.6.5 PSNEXT Loss**

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of 8 results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 MHz through the highest applicable frequency and the step size may not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.6.6 ELFEXT Loss, pair-to-pair**

Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through the highest

applicable frequency and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as in Table 1, column 2. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.6.7 PSELFEXT Loss**

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations.

Each wire-pair is evaluated from 1 MHz through the highest applicable frequency in frequency increments that do not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.6.8 Return Loss**

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the highest applicable frequency in increments that do not exceed the maximum step size defined in the draft standard as shown in Table 1, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.6.9 Propagation Delay**

Propagation delay is the time required for the signal to travel from one of the link to the other.

This measurement is to be performed for each of the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

#### **B.6.10 Delay Skew**

This parameter shows the difference in propagation delay between the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pairs with the worst-case propagation Delay skew. The report shall include the Delay skew value measured as well as the test limit value.

#### **B.6.11 ACR (Attenuation to crosstalk ratio)**

This parameter is not required by TIA standards but may be expected in order to obtain the premise wiring manufacturer's warranty.

ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.6.12 PSACR**

This parameter is not required by TIA standards but may be required in order to obtain the premise wiring vendor's warranty. The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of all adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

**2016 E-RATE NETWORK EQUIPMENT AND RELATED SERVICES****B.7 Electronic Tests**

The Owner's Quality Assurance Team randomly selects cables for testing and every effort shall be made to avoid a typical testing pattern from communications cabinet to work area outlet, so that no testing pattern is discernible. The testing personnel shall inspect all drops on the faceplate in multiple cases to ensure all cables are labeled and no cross connects are visible, etc. The testing personnel shall perform a Q/A review of the cable termination(s) in the Communications cabinet(s) and the corresponding user location of selected cables (e.g., the faceplate labels or terminations behind the termination panel). The personnel must be consistent in testing selected cables.

**B.8 Data Accuracy**

Tests shall be conducted on the premise that ANSI/TIA -568 C and other applicable specifications were applied to the cable installation. Further, the Owner's Quality Assurance Team shall be provided the test result book to verify the CONTRACTOR tested 100 percent of their work, so the sampling tests performed ensures system operability and customer satisfaction. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The CONTRACTOR shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

**B.9 Data and Test Reporting**

The Quality Assurance Report shall clearly identify the test environment, test equipment used, name of each tester, acceptable results, and actual results for each test performed. If a failure occurs, the test shall proceed, with the failure reported to the responsible CONTRACTOR for repair at test end.

**B.10 Communications Wiring Electrical Tests**

The test parameters for Category 5e and Category 6 are defined in ANSI/TIA-568-C.2 standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 350 MHz) must meet or exceed the limit value determined in the above-mentioned standard.

### **B.10.1 Wire Map**

Wire Map shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

### **B.10.2 Length**

The field tester shall be capable of measuring length of all pairs of a permanent link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation. The physical length of the link shall be calculated using the pair with the shortest electrical delay.

This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

### **B.10.3 Insertion Loss (Attenuation)**

Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz, through the highest applicable frequency. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.

Minimum test result documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs and the test limit value at this frequency.

### **B.10.4 NEXT Loss**

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the highest applicable frequency. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case).

**Table 2**

Frequency Range (MHz)	Maximum Step Size (MHz)
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50
250-350	1.00

NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.10.5 PSNEXT Loss**

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of eight results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 MHz through the highest applicable frequency and the step size may not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.10.6 ELFEXT Loss, pair-to-pair**

Pair-to-pair FEXT Loss shall be measured for each wire-pair combination from both ends of the link under test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ELFEXT Loss that must be evaluated and reported in the test results. ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ELFEXT is to be measured from 1 through the highest applicable frequency and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the draft standard as in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination

that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.10.7 PSELFEXT Loss**

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations.

Each wire-pair is evaluated from 1 MHz through the highest applicable frequency in frequency increments that do not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.10.8 Return Loss**

Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the highest applicable frequency in increments that do not exceed the maximum step size defined in the draft standard as shown in Table 2, column 2.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.10.9 Propagation Delay**

Propagation delay is the time required for the signal to travel from one of the link to the other.

This measurement is to be performed for each of the four wire pairs.

Minimum test result documentation (summary results): Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

#### **B.10.10 Delay Skew**

ANSI/TIA-568-C indicates that this parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero.

Minimum test result documentation (summary results): Identify the wire pairs with the worst-case propagation Delay skew. The report shall include the Delay skew value measured as well as the test limit value.

#### **B.10.11 ACR (Attenuation to crosstalk ratio)**

This parameter is not required by TIA standards but may be expected in order to obtain the premise wiring manufacturer's warranty.

ACR provides an indication of bandwidth for the two wire-pair network applications. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two wire-pair system. This calculation yields 12 combinations – six from each end of the link. Minimum test result documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

#### **B.10.12 PSACR**

This parameter is not required by TIA standards but may be required in order to obtain the premise wiring vendor's warranty. The Power Sum version of ACR is based on PSNEXT and takes into account the combined NEXT disturbance of all adjacent wire pairs on each individual pair. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

Minimum test result documentation (summary results): Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSACR. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

## APPENDIX C - FIBER OPTIC CABLE PERFORMANCE TESTS

### C.1 Overview of Cable Tests

ANSI/TIA-568-C.0 indicates that the optical fiber cable construction shall consist of 50/125 mm or 62.5/125 mm multimode optical fibers or single mode optical fibers, or a combination of these media. Multimode fiber shall have a graded-index optical fiber waveguide with nominal 50/125  $\mu\text{m}$  for installations following specification 25569, or 62.5/125  $\mu\text{m}$  core/ cladding diameter for installations following specification 25568. Primary and secondary backbone cable testing shall be equivalent to backbone cabling as defined in ANSI/TIA-568-C.0 such as cabling interconnecting telecommunications closets, equipment cabinets, and entrance facilities. Therefore, the Owner's Quality Assurance Team shall observe the following interrelated tests:

1. Verification of multi-mode fiber optic cable installations.
2. Verification of single-mode fiber optic cable installations.
3. Electronic measurement of the distance and equivalent attenuation per kilometer (km) to verify minimum data transmission capacity per specification.
4. Total link attenuation measurements.

### C.2 Test Equipment

The following test equipment shall be used:

1. Fluke DTX-1800 tester or DSX-5000 Level V with copper, single mode and multi-mode power meter and light source heads or current equivalent

#### C.2.1 Cabling Distance

The Multi-mode strands shall primarily be utilized by the network electronics up to 400 meters and testing shall conform to OFSTP-14A. The Single mode strands shall be required where the Backbone distance exceeds 400 meters. Single Mode testing shall conform to OFSTP-7.

### C.3 Test Procedures

For multi-mode and single mode fiber the CONTRACTOR's Test Team shall use the Fluke DTX 1800 or DSX-5000 Level V tester with single-mode and multi-mode power meter and light source heads. The specific nanometer wavelength(s) at which the single-mode fiber shall be tested (i.e., 1310 nm and/or 1550 nm) shall be determined based on the length of the fiber cable being tested.

### **C.3.1 Cable Distance**

Using the Fluke DTX 1800 or Fluke DSX-5000, CONTRACTOR's Test Team shall determine the overall fiber optic cable length to ensure the cabling distance is within the maximum allowable length.

### **C.3.2 Attenuation**

The backbone optical fiber cabling link segment should be tested in one direction at both operating wavelengths, to account for attenuation deltas associated with wavelength.

The CONTRACTOR's Test Team shall use the Fluke DTX 1800 or Fluke DSX-5000 to measure the attenuation due to fiber optic cable and connectors. The Owner's Quality Assurance Team shall observe tests and observe the recording of attenuation at both 850nm/1300nm for each Multi-mode and 1310nm/1550nm for Single-mode fiber optic strand respectively terminated under this initiative. These tests shall be performed at each communications cabinet and from the MDF cabinet, as required.

### **C.3.3 Information Transmission Capacity**

The fiber optic cable is assumed to be within the allowable attenuation per kilometer as specified in ANSI/TIA-568-C.3. The Owner's Quality Assurance Team shall presume the transmission capacity of the cable is within specification.

### **C.4 Data Reporting and Accuracy**

The CONTRACTOR's Test Team shall report loss measurement results, with locations and wavelength identifications, to the Owner in accordance with EIA/TIA OFSTP-14 and OFSTP-7. The CONTRACTOR shall provide copies of the test results in native format to the Owner's Quality Assurance team at the conclusion of the Structured Cabling Testing or any time during the testing process.

## **APPENDIX D - PHYSICAL CONFIGURATION AUDIT**

### **D.1 Overview of Physical Connectivity Audit**

A Physical Connectivity Audit is completed comparing the CONTRACTOR supplied Equipment Inventory List (EIL) against the Cabinet Equipment Survey generated by the test team at Quality Assurance. This appendix provides the detailed audit of all the physical equipment and materials installed under this expansion effort.

### **D.2 Physical Connectivity Audit Quality Assurance Review lists**

The following sample form shows the general information to be documented for a standard Cabinet Equipment Survey.

Site \_\_\_\_\_ Date \_\_\_\_\_ Tester(s) \_\_\_\_\_

Building and Communications Cabinet Numbers \_\_\_\_\_

## **APPENDIX E - CABLE DOCUMENTATION SPECIFICATION**

### **E.1 Documentation.**

- E.1.1** The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
- E.1.2** Individual test reports shall be submitted in native format / electronic format. Hand-written test reports are not acceptable.
- E.1.3** The test results records saved by the tester shall be submitted to the Owner with all applicable test data graphs in electronic format. The test result submittal shall include updated network cabinet cable charts.
- E.1.4** Electronic reports are to be submitted in DVD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. Electronic reports must be accompanied by a Certificate signed by an authorized representative of the CONTRACTOR warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
- E.1.5** Test reports shall include the test measurement information specified in Section 5 for each cabling element tested, in addition to:
- E.1.6** Cable manufacturer, cable model number/type and NVP.
- E.1.7** Tester manufacturer, model, serial number, hardware version and software Version

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- E.1.8** Circuit ID number.
- E.1.9** Auto test specification used.
- E.1.10** Identification of the tester interface.
- E.1.11** Overall pass/fail indication.
- E.1.12** Date and time of test.

PROJECT NAME:  
SCHOOL NAME:

02/22/2017  
QUALITY ASSURANCE TREST AND ACCEPTANCE REQUIREMENTS  
FOR NEW AND EXISTING FACILITIES  
27 0127-26

**Form 425 - 48 Hour notice: Request for Owners Quality Assurance**



**Los Angeles Unified School District**

Information Technology Division

IT Infrastructure Project Management Office

**48 Hour notice: Request for Owners Quality Assurance**

**Date:**

\_\_\_\_\_

**School:**

\_\_\_\_\_

**Project:**

\_\_\_\_\_

**Project No :**

\_\_\_\_\_

**Vendor Name**

\_\_\_\_\_

This request for Owners Quality Assurance certifies that the site is ready to begin the QA process and acknowledges that the following is complete.

- All requirements of the Statement of Work and relevant District specifications have been completed and verified by the Vendors Quality Control Manager.
  
- A soft copy of Form 502, Asset List has been submitted at least 48 hours prior to QA site walk. A hard copy of same will be presented to Owners QA representative at the time of the QA site walk.
  
- The most recent, accurate Logical Network Diagram will be provided to Owners QA representative at the initiation of the QA site walk.
  
- All previously noted deficiencies have been corrected.
  
- All redlined construction drawings are up to date and available at the construction site.
  
- 100% of the cable test results in native format have been submitted to and approved by the ITIPMO prior to requesting Owners QA services.
  
- CONTRACTOR confirms that all active equipment is racked and fully functional.

Project General Superintendent

(print name)	(signature)	(date)
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Project Area Superintendent

(print name)	(signature)	(date)
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PROJECT NAME:  
SCHOOL NAME:

02/22/2017  
QUALITY ASSURANCE TREST AND ACCEPTANCE REQUIREMENTS  
FOR NEW AND EXISTING FACILITIES

27 0127-27

## SECTION 27 1013

## STRUCTURED CABLING (EXISTING SITES)

## PART 1 - GENERAL

## 1.01 SUMMARY

- A. This specification describes the equipment provisioning, installation, integration, configuration, testing, and documentation of wiring/cabling and associated pathways for Local Area Networks, Signal Terminal Cabinets, and Telephone systems at the Los Angeles Unified School District (LAUSD). This specification uses 62.5 micron multi mode fiber and Category 5E UTP cable and shall be used for additions and modifications at facilities already using the same type of cable plant. Pertinent sections are broken down to reflect the requirements for each system individually.
1. Comply with individual system specifications.
- B. Principal items of Work in this Section shall include labor and materials that consist of provisions, installing, terminating, testing, and documenting a complete and fully functional communications structured cabling system. The work shall include the following:
1. Local Area Network Wiring:
    - a. The installation of either new LAN cabling or additional LAN cabling. Segments, new installations, and/or modifications shall not interfere with or disable any portion of existing, working LANs.
    - b. Provide rack space to allow a 50 percent expansion of the number of network data drops provided at the time of initial configuration. This includes space for additional structured cable components as well as active Ethernet equipment. Calculate rack space for one 24 port switch per 20 Category 5E drops in IDFs and LDFs. Allow two rack units (1.75 inches per RU) per switch.
    - c. Conduct underground survey to ensure constructability of outside plant pathway routing.
    - d. Provide exterior and interior optical fiber and copper cabling. LAUSD uses a centralized optical cabling system in accordance with ANSI/TIA 568-C standards. Cabling system colors shall be coordinated using consistent colors for the same type of cabling as indicated elsewhere in this specification.

- e. Install and connect Owner Furnished, rack mounted uninterruptible power supplies and Ethernet switches in equipment cabinets at locations with active equipment.
- f. Furnish and install cabinets/racks, vertical power strips, cable trays and cable management at the MDF.
- g. Furnish and install modular T-568-B patch panels for termination of UTP within the MDF, IDF, and LDF. Use fiber patch cabinets for fiber optic cable terminations located in the MDF, IDF, and LDF where copper drops are provisioned.
- h. Furnish and install connectors and faceplates and terminate cable as specified.
- i. Provide high impact plastic wall and/or faceplate covers and connector housings for communication systems outlet locations.
- j. Provide contiguous (home run cables with service loops) optical fiber and copper backbone, link and distribution cables. No splices are permitted between designated termination points.
- k. Furnish and install floor mounted equipment racks, with required CBC Seismic Design rated seismic bracing and associated accessories in telecommunications spaces where required.
- l. Furnish and install grounding and bonding of communications components per the CEC.
  - 1) Telecommunication Entrance Facilities, Minimum Point of Entry locations, and MDF locations shall be equipped with a telecommunications main grounding busbar or telecommunications grounding busbar as appropriate to the installation environment.
  - 2) Grounding Equalizers or Telecommunications Bonding Backbone Interconnecting Bonding Conductors are not required except in buildings exceeding two occupied stories which use building steel to ground electrical service panels.
  - 3) In buildings with two stories or less, where electrical panels are grounded using CEC compliant grounding conductors directly connected to the building ground electrode, IDFs, and LDFs equipment chassis; associated peripherals shall use local panel ground via the equipment branch circuit grounding conductor.
- m. Furnish and install full labeling of the entire installation prior to testing in accordance with Article 3.04 paragraph C of this specification.

- n. Premise cable shall be tested in compliance with Specification 27 0126. Testing of each LAN optical fiber element and connector with Power Meters and OTDR. For multi-pair copper communications cable, test pairs within counts and binder groups to ensure that no less than 99 percent of the pairs of a multi-pair cable achieve continuity and operation in voice band tests. For Category 5E copper cable, test and certify 100 percent of drops using test equipment certified for Level III test equipment.
2. Telephone Systems Wiring:
    - a. Install and connect Owner furnished telecommunications equipment cabinet, attendant consoles, and telephone instruments as indicated on Drawings or in Scope of Work.
    - b. Furnish, install, and connect ground wire and power supplies as specified and/or required. Coordinate provision of dedicated power outlets.
    - c. Furnish and install connecting wiring and modular jacks to each individual phone location as indicated on Drawings. This also includes necessary cross connect blocks and cross connect wiring in cabinets/racks, as necessary to provide for functions and requirements specified. Cables shall be installed in conduits, cable trays, or raceways unless indicated otherwise on Drawings. Cabling system colors shall be coordinated using consistent colors for the same type of cabling as described in Article 2.04 of this specification.
    - d. Provide and install pathway and inside cabling from the MDF to the Minimum Point of Entry (MPOE) and install pathway from MPOE to the property-line Public Switch Telephone Network demarcation.
    - e. Provide infrastructure and facilities for interfacing the site's telecommunications infrastructure with public utilities telephone lines at the MPOE. Provide underground telephone service conduit from public utility serving location to main telephone terminal as indicated on Drawings and in compliance with requirements of access provider.
    - f. Coordinate the installation and location of surge-protected outlets in equipment cabinets and enclosures where active equipment is scheduled.
    - g. Furnish and install 110 type telephone punch blocks at PBX location using multi-pair cable for interconnection to the MDF and IDFs, as required.

- h. Provide coordination, testing, materials, and components required to provide a complete and operational installation.

C. Related Requirements:

- 1. Section 00 7000: General Conditions.
- 2. Division 01 - General Requirements.
- 3. Section 01 7700: Contract Closeout.
- 4. Section 06 1000: Rough Carpentry.
- 5. Section 26 0500: Common Work Results for Electrical.
- 6. Section 26 0513: Basic Electrical Materials and Methods.
- 7. Section 26 0526: Grounding and Bonding.
- 8. Section 26 0533: Raceways, Boxes, Fittings, and Supports.
- 9. Section 26 2416: Panelboards and Signal Terminal Cabinets.
- 10. Section 27 5128: Public Address Systems (Auditoriums, Performing Art, M-P Rooms) (MS and HS).
- 11. Section 27 5129: Public Address Systems (Gymnasiums).
- 12. Section 27 5130: Public Address Systems (Athletic Fields).
- 13. Section 31 2323: Excavation and Fill for Utilities.

D. Acronyms: See Appendix 1.

E. Definitions: See Appendix 2.

1.02 SYSTEM REQUIREMENTS

A. Local Area Networks:

- 1. This specification describes the design, installation, testing, and documentation of elements for premise wiring installations and should be read in conjunction with other applicable divisions and sections of the contract documents. Furnish labor, supervision, tooling, miscellaneous mounting hardware, and consumables, including patch cables, for systems installed; in addition, provide construction and integration services to achieve connectivity for classrooms, computer laboratories, libraries, instructional areas, offices, and work areas, as specified by the LAUSD point of contact. Provide necessary labor and materials for a complete and operable installation.

B. Signal Terminal Cabinets:

1. Terminal cabinets shall be flush type, with two-inch trim or surface mounted type, as indicated on Drawings. Terminal cabinets shall be furnished with sections and barriers to separate each system. Sections over 24 inches in width shall be provided with double doors and locks. Terminal cabinets shall measure 12 inches wide by 18 inches high by 5  $\frac{3}{4}$ -inches deep, unless otherwise indicated on Drawings. Trims for sectional cabinets shall be of one-piece construction.
2. Terminal cabinets shall be furnished with 3/4-inch thick plywood backboards within cabinets, fastened in place with machine screws. Backboards shall be largest size that cabinet and conduit terminations will permit.
3. Flush-mounted terminal cabinets shall be finished as specified for flush-mounted panelboard cabinets. Surface and semi-flush mounted terminal cabinets shall be finished as specified for surface-mounted panelboard cabinets.
4. Terminal Cabinets for exterior Ethernet drop locations shall be NEMA Type 3R continuous hinge cover enclosure with a pad lockable draw pull catch or cylinder lock on the opposite side. The enclosure and cover shall be built of 16 gage galvanized steel and shall carry a NEMA 3R rating. The enclosure shall be large enough to fit a weatherproof single gang deep box and an industrial type Category 5E patch cord 10 feet long as described in paragraph 2.02.N. of this specification. Provide a padlock or cylinder lock keyed to Corbin CAT 80 for each enclosure.

C. Telephone Systems:

1. The scope of this specification covers the conduits and supporting structure for system's cables but not the placement, installation, or termination of cables. These cables connect to the patch panel(s) either by means of Amphenol connectors or punch down connections. Cables shall be designated as follows:

CABLE DESIGNATION	
TYPE	DESCRIPTION
A	Service entrance cables installed by the service provider.
B	Interior grade, multi-pair PVC cables. To be terminated on 110-type blocks.
C	Interior PVC, multi-pair cables, or exterior shielded cables for installation on buried conduit.
D	Category 5E or 6 cables terminated on the patch panel on one end, and on an RJ-45 wall jack insert on the other end.

### 1.03 SUBMITTALS

- A. Materials list of items proposed to be provided under the specification.
- B. Furnish catalog cuts, technical data, and descriptive literature on components. Data shall be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data.
- C. Shop Drawings shall indicate equipment locations, wiring and schematics, details, panel configurations, sizes and a point-to-point wiring diagram of circuits. Shop Drawings shall indicate interfaces to equipment furnished by others, identifying numbers of wires, termination requirements, and other pertinent details. Responsibility for each end of interfaces shall be noted on Shop Drawings.
  - 1. For Signal Terminal Cabinets: Shall include a front elevation indicating cabinet dimensions, make, location, and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.
- D. Each submittal shall be bound and shall contain an index organized vertically by assembly and item number and horizontally by columns. The first assembly shall be the major head end equipment. The leftmost column shall be the item number; next shall be the description, followed by the applicable specification section number, and followed by the specified item, which is followed by the submitted item. The rightmost column shall be for notes, which shall be used to reference the reason for submitting items other than as specified.
- E. Each submittal shall contain product data sheets or catalog cut sheets for each item listed in the Index. These shall be arranged in the same order as the index and if more than one item is shown, the submitted items shall be highlighted or marked with an arrow. The product data shall be sufficiently detailed to allow the engineer to evaluate

the suitability of the product and to allow other trades to provide necessary coordination.

- F. Provide Shop Drawings, in the same size as the Drawings, prepared and signed by a BICSI Registered Communications Distribution Designer (RCDD). Shop Drawings shall be prepared in latest version of AutoCAD with three CD-ROM electronic copies submitted along with full sized Shop Drawings.
- G. Submit Shop Drawings prepared, signed, and sealed by structural engineer licensed in the State of California. Details shall be provided indicating the proposed means of support and attachment of wall and floor mounted racks. Calculations shall be based on the maximum seismic loads as determined by the CBC based on specifications provided by the cabinet manufacturer. MDF racks or cabinets shall support a minimum of 750 pounds of static weight. IDF racks or cabinets shall support a minimum of 250 pounds of static weight. LDF racks or cabinets shall support a minimum of 125 pounds of static weight.
- H. Provide a Network Protection Plan that defines how an existing school or campus Local Area Network (LAN) will remain in service during the installation of either new LAN cabling or additional LAN cabling segments in a manner that ensures the installation shall not interfere with or disable any portion of existing, working LANs during the project. This plan should be prepared by the Installer and approved by the Architect prior to the start of work.
- I. Samples: Provide samples of material and equipment as required by the Architect. If Samples are requested, they shall be submitted within ten days from date of request.
- J. Submit one electronic and one paper copy of cable records. Examples of the format for the required cable records are contained in Attachment 3 of this specification.

#### 1.04

#### CODES AND STANDARDS

- A. Complete installation shall meet or exceed the latest edition of following standards:
  - 1. Underwriters Laboratories Inc. (UL): Applicable listings and ratings.
  - 2. UL 50, Cabinets and Boxes.
  - 3. UL 943, GFCI.
  - 4. UL 489, Molded Case Circuit Breakers.
  - 5. California Building Code.
  - 6. California Electrical Code.
  - 7. California Electrical Code, Article 384, 770, 800, latest issue.

8. National, State, and Local Occupational Safety and Health Administration (OSHA) building and fire codes.
9. NEMA PB1.
10. Federal Specifications W-P- 115C and WC-375B.
11. ANSI/TIA/EIA Telecommunications Building Wiring Standards.
12. ANSI/TIA-568-C, Commercial building telecommunications wiring standard and current addenda.
13. ANSI/TIA/EIA-568-C.3 Optical Fiber Cabling Components Standard.
14. ANSI/TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, current issue.
15. ANSI/TIA/EIA-569-A-1, Commercial Building Standard for Telecommunications Pathways and Spaces Addendum 1 - Surface Raceways (March 2000).
16. ANSI/EIA/TIA-598-A, Optical Fiber Cable Color Coding, current issue.
17. ANSI/TIA/EIA-606-A, The Administration Standard for the Telecommunications Infrastructure of Commercial Building, current issue.
18. ANSI/TIA/EIA-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications, current issue.
19. ANSI/TIA/EIA-758-A, Customer-Owned Outside Plant Telecommunications Cabling Standard, current issue.
20. Institute of Electrical and Electronic Engineers (IEEE) 802.3 (Ethernet), 802.3Z (Gigabit Ethernet over optical fiber), 802.3ab (Gigabit Ethernet over 4 pair category 5 or higher), 802.11 (Wireless LAN).
21. BICSI Telecommunications Distribution Methods Manual, current issue.
22. FCC Part 68.50.
23. National Electrical Manufacturer's Association (NEMA).
24. National Fire Protection Association (NFPA), NFPA-70.
25. CCR Part 3 - California Electrical Code.
26. CCR Part 2 - Uniform Building Code.

## 1.05 SYSTEM DESCRIPTION

- A. Local Area Network Cabling Infrastructure: The network-cabling infrastructure at each school will utilize a star topology design consisting of horizontal cabling, backbone cabling, and various telecommunications cabling pathways and spaces. Schools will require design-engineering services to determine the best route and method for cable conveyance throughout the school in accordance with project requirements and applicable installation standards.
1. Proposed solutions shall be in compliance with TIA/EIA 568-C, centralized optical cabling, with the single exception of allowable cabling distance. TIA/EIA 568-C Annex A allows 300 meters as a maximum multi-mode optical fiber cable distance but District specification allows a maximum total length of 550 meters (450 meter backbone + 90 meter horizontal) using high grade laser optimized 62.5 micrometer multi-mode optical fiber. The installation of the backbone and horizontal cable plant shall include the following:
    - a. 62.5 micron multi-mode solutions which require mode-conditioning patch cords when using VCELS to launch in the 850 nm launch window shall not be accepted.
    - b. The interconnect or splice method as shown in figure 3 of ANSI/TIA 568-C shall be used in all cases. The pull through and splice methods are not acceptable.
    - c. Installation of optical fiber backbones in strand counts adequate to cross-connect active classroom, and instructional support location horizontal fiber to the BBS including a minimum of 10 percent spare strands, in multiples of six strands, in each backbone cable. Fiber termination units (FTU) are required to cross-connect backbone fiber at both the main equipment (MDF) cross-connect and at secondary (IDF) cross-connect locations throughout the campus.
  2. Backbone Cabling - The backbone cabling as a minimum, unless otherwise noted, shall be an indoor-outdoor, Riser rated hybrid multi-mode/single-mode fiber optic cable with a minimum composition of 12 strand multi-mode and six strand single-mode fiber optic cabling for inter-building and intra-building backbone cabling. Backbone cables shall meet or exceed the ICEA-S-104-696 Standard for Indoor-Outdoor Optical Fiber Cable. Connectors, distribution panels, ferrules, enclosures, and consumables shall be included to provide the backbone connectivity between MDFs and IDFs. Designer will show calculations and provide drawings illustrating distance limitations.
  3. Horizontal Cabling – Each data outlet unless otherwise noted shall consist of either one Category 5E cable or one Category 5E and four strands of fiber optic cable for classroom locations and six strands for connection to LDFs in locations such as computer labs, libraries and cafeteria.

- a. Each Category 5E cable shall be terminated on an eight-position, eight-conductor Category 5E jack wired in accordance with T568B. Associated faceplates shall accommodate two jacks at a minimum. Within classrooms and other open spaces, Category 5E cabling shall be routed via EMT conduit or surface mount raceway in walls, and in J-hook in accessible spaces above ceilings, cables shall be routed from the patch panel to a data outlet and placed as close to each workstation as practical. Supply Category 5E rated patch panels and same manufacturer patch cords for telecommunications closets and workstations to maintain an end-to-end Category 5E channel for horizontal cabling.
  - b. Existing horizontal fiber terminated at a user station may be rerouted to new network cabinets. Remove any obsolete secondary backbone fiber with new cabling where appropriate.
4. Each campus shall receive a minimum of one Main Distribution Frame (MDF). Depending upon the size of the facility, provide one or more Intermediate Distribution Frames (IDFs), and Local Distribution Frames (LDF) are required. Telecommunications spaces will be located in secure areas with proper ventilation, HVAC, power, lighting, and grounding. MDFs and IDFs shall accommodate horizontal and backbone cabling termination equipment including: 19-inch free standing racks, wall-mounted racks, or cabinets, patch panels, vertical and horizontal wire management, patch cables, ladder racking, conduit sleeves, and data electronics. IDFs shall be located within the campus buildings in sufficient quantity to maintain compliance with the 90 meter horizontal cable running distance limitations as specified in ANSI/TIA 568-C.1. LDFs shall be located within every computer lab, student nutritional service area, multi-purpose room, and library to support ESM equipment.
5. If not in the same room, the MDF shall be located as close to the Minimum Point of Entry (MPOE) as practical.
6. WAN Cabling: If the MPOE is in a separate room from the MDF, furnished cabling between the MDF cabinet and the MPOE shall consist of:
- a. Four separate four-pair 22AWG individually shielded cables with an outer sheath, properly terminated with RJ48C surface mount jacks at each end. Provide service loops of at least ten feet at the MDF and 25 feet at the MPOE cross-connect locations.
  - b. Fiber optic backbone WAN connection - unless otherwise noted, shall be an indoor-outdoor, riser rated multi-mode fiber optic cable with a minimum composition of six strands multi-mode fiber optic cable for inter-building and intra-building backbone cabling. Cables shall meet or exceed the ICEA-S-104-696 Standard for Indoor-Outdoor Optical Fiber Cable. Connectors, distribution panels, ferrules, enclosures, and

consumables shall be included to provide connectivity. Refer to Article 2.02 for multi-mode Optical Fiber type and performance requirements.

- c. WAN cables shall be clearly tagged in accordance with the requirements of this Specification. Provide a dedicated surface raceway and/or EMT conduit for this cable.

#### B. Signal Terminal Cabinets

1. Signal terminal cabinets shall conform to the Specifications in Section 26 2416, except as modified herein.
2. Terminal cabinets shall be flush or surface type with two-inch trim or surface mounted type, as indicated on Drawings. Terminal cabinets shall be provided in sufficient quantity to allow no more than one signal system per cabinet. Terminal cabinets shall measure a minimum of 12 inches wide by 18 inches high by 5  $\frac{3}{4}$ -inches deep, unless otherwise indicated on Drawings. Trims for sectional cabinets shall be of one-piece construction.
3. Cabinet Boxes shall be fabricated of galvanized steel compliant with NEMA 250; unless otherwise noted. Boxes shall be flush or surface type with removable end-walls, and dimensioned as indicated on Drawings. Provide  $\frac{3}{4}$ -inch thick plywood backboard fastened in place with machine screws and painted matte white with fireproof paint for mounting terminal blocks. Backboards shall be largest size that cabinet and conduit terminations will permit.
4. Cabinet fronts shall be fabricated of steel compliant with NEMA 250, unless otherwise noted. Fronts shall be flush or surface type as indicated on Drawings, with screw cover front and gray baked enamel finish. Doors shall be cut true, and shall accurately fit opening and finish smoothly across joints. Rabbets shall be inside. Hinges shall be entirely concealed except for barrels and pins. Hinge flanges shall be welded to door and trim. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors, keyed to Corbin No. 90 keys.
5. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.
6. Terminal Cabinets shall be located so they are readily accessible and not exposed to physical damage.
7. Cabinet locations shall provide sufficient working space around panels to comply with the California Electrical Code and the BICSI TDMM.
8. Terminal Cabinets shall be securely fastened to the mounting surface by at least four points.

9. Unused openings in cabinets shall be effectively closed.
10. Cabinets shall be grounded as specified in Article 250 of the California Electrical Code.
11. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.
12. Maintain the required bending radius of cable and conductors inside the cabinet.
13. Clean the cabinets of foreign material such as cement, plaster, metal filings, and paint.
14. Remove debris from terminal cabinet interior.

C. Telephone Systems:

1. The telephone wiring system consists of distribution and feeder cables that permit connection of telephone handsets or other interfacing devices, through cross connecting panels, back to connecting blocks associated with an Owner-furnished, Owner installed PBX System. The installation of the PBX system and related powering systems is outside the scope of this specification.
2. The quantity of Telephone System cabling shall be designed based upon the size and scope of the project, or in accordance with drawings furnished by a designer. Telephone cables installed between the Main Distributing Frame (MDF) or PBX system location and respective Intermediate Distribution Frames shall be the sum of current telephone requirements plus a 40 percent growth factor of spare cable pairs.
3. Equipment specifications for the Project site shall be as indicated on Drawings, the scope of work, and as specified herein.

D. Underground service entrances are required for connections to:

1. Telephone Service Provider.
2. Community Antenna Television (CATV) Access Provider.

1.06 QUALITY ASSURANCE

- A. In addition to the following requirements, review and comply with Section 27 0126 - Test and Acceptance Requirements for Structured Cabling.
- B. Use adequate numbers of skilled personnel who are manufacturer certified, trained and experienced on the necessary crafts, and familiar with the specified requirements and methods needed for the proper performance of the work.

- C. The work of this section shall conform to California Code of Regulations, Part 3, and other applicable codes and standards.
- D. Permits and Inspections: Obtain and pay for required permits and inspections; deliver certificates of inspection to the Inspector.
- E. Only a qualified Installer holding licenses required by legally constituted authorities having jurisdiction over the work, shall do the work.
  - 1. Contractor shall have completed at least five projects of equal scope to systems described herein and shall have been in the business of supplying and installing specified type of systems for at least five years.
  - 2. Include in the Product Data list submission, copies of current manufacturer certificates indicating that the Contractor is an authorized distributor of the manufacturer's products, has been trained in the installation of those products, and has a service organization capable of responding within 24 hours of receipt of written notification and resolution within one day for MDF equipment and five days for equipment located either in the classrooms, IDFs, or LDFs.
- F. Material or work damaged during the planning, installation, testing, and clean-up of this project must be replaced or repaired, at no expense to the Owner, to meet current Owner specifications before final acceptance of work. Examination of, or failure to examine, work by the Owner shall not relieve Contractor from these obligations.
- G. Installation shall be performed in accordance with applicable building codes, industry standards, and best trade practices.
- H. Include in the Material List Submission copies of the manufacturers' certifications that the Contractor is a current authorized distributor of the submitted manufacturers' products and Contractor's staff has been adequately trained and certified in the installation of those products. This requirement applies to structured cable components and cable described in this specification.
- I. Coordinate cable runs and rack equipment locations with the Owner's Authorized Representative prior to the start of construction. Contractor and Owner's Authorized Representative must agree as to the final location of devices and the cable plant design.

## 1.07

**WARRANTY**

- A. Warranty that work executed and materials furnished shall be free from defects in materials, fabrication and execution for a minimum period of three years from date of installation acceptance, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. In the event a manufacturer's warranty is longer than three years, the manufacturer's warranty shall be the warranty period. Immediately upon receipt of written notice from the District, repair or replace at no expense to the District, any defective material or work that may

be discovered before final acceptance of work or within the warranty period; any material or work damaged thereby; and adjacent material or work that may be displaced in repair or replacement. Examination of or failure to examine work by the District shall not relieve Contractor from these obligations.

- B. Provide a performance warranty for the installed data cabling system and components for a minimum of fifteen years after system is turned over to the Owner. Components of the optical data backbone cable system including cables, distribution shelves, LIUs and connectors must carry a fifteen year single manufacturer's applications warranty at speeds of one Gbit/second.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT STANDARDS - APPLIES TO ALL SYSTEMS

- A. Where required by Specifications, components installed under this Contract shall be listed by UL or another Nationally Recognized Testing Labs (NRTL).
- B. Equipment Requirements.
1. Various manufacturers' equipment may meet the standards of quality set by the Owner. Provide equipment specification sheets for items included in the submitted bid.
  2. The Owner's Quality Control representative or designated agent will establish equivalency and compliance of product or components offered for use under this Contract.

### 2.02 LOCAL AREA NETWORK CABLING

#### A. Multi-Mode Optical Fiber.

1. The optical fiber shall be multimode, graded-index optical fiber waveguide with nominal 62.5/125 micron core/cladding diameters. The optical fiber shall comply with ANSI/EIA/TIA-492AAAA.
2. The mechanical and environmental specifications for multi-mode fiber distribution cables shall be indoor/outdoor, riser rated, tight-buffered type cables. The cable shall meet the requirements of the California Electrical Code (CEC) section 770 and the requirements of TIA-455-82B water ingress test. Confirm that the cable is listed for the specified application.
3. Cabled optical fiber shall meet the graded-index attenuation performance specifications of ANSI/TIA 568-C including current sub sections and addendum. Attenuation shall be measured in accordance with ANSI/EIA/TIA-455-46, -53, or -61. Information transmission capacity shall be measured in

accordance with ANSI/EIA/TIA-455-51 or -30. The cable shall be measured at 23 degrees C  $\pm$  5 degrees C.

4. Multi-mode optical fiber shall meet the following minimum performance requirements:
  - a. Attenuation: The maximum attenuation of the multi-mode laser optimized fiber shall be 3.5db/km or less at 850nm and 1.5db/km or less at 1300nm.
  - b. Utilize GbE Gigabit Enhanced 62.5/125 multi-mode fiber to exceed standard bandwidth and distance limitations. Cable manufacturer shall guarantee that the multi-mode optical cable will support Gigabit Ethernet transmission up to 550 meters using SX optics.

B. Single-Mode Optical Fiber.

1. Single-mode optical fibers shall be Class IVa Dispersion-Unshifted Single-mode Optical Fibers and shall comply with ANSI/EIA/TIA-492BAAA. Fiber conductors shall have a nominal core diameter of 8.7 microns. Cable shall have transmission window centered at 1310 and 1550 nanometer wavelengths.
2. The mechanical and environmental specifications for single-mode fiber distribution cables shall be indoor/outdoor, riser rated, tight-buffered type cables. The cable shall meet the requirements of the National Electrical Code (NEC) section 770 and the requirements of TIA-455-82B water ingress test. The Installer shall confirm the cable is listed for the specified application.
3. Cabled optical fiber shall meet the attenuation performance specifications of ANSI/TIA-568-C. Attenuation shall be measured in accordance with ANSI/EIA/TIA – 455-78ASP-3-3644-RV2 or 61. The cable shall be measured at 23 °C  $\pm$  5 °C.

C. Fiber Optic Connectors. Fiber optic connectors shall be Duplex SC type, MM or SM connector.

D. Fiber Optic Light Interconnection Units (LIUs). Rack mounted with the capacity to handle a minimum of 18 terminated fibers. Complete kit to include panels' bulkheads and supporting hardware.

1. LIU for Local Distribution Frames and other locations requiring 18 optical fiber strands or less shall not exceed one EIA rack unit in height.

E. Fiber Optic Distribution Shelves. 72 port rack mountable, with SC-compatible bulkheads and built-in cable management.

- F. Multimedia patch panels for LDC and LDF cross connections: Rack mounted field configurable panels for mixed media installations. The panel shall have a variety of modular inserts which support as a minimum Category 5E and duplex SC connectors.
1. Patch panels for LDF cabinets shall support a minimum of three duplex SC optical fiber connectors and Category 5E connections as required by the number of drops supported at that distribution point.
- G. Fiber Optic Jumper Cables.
1. Multi-mode or Single-mode duplex cable, OFN rated. Length: three meters, at a minimum, pre-manufactured with SC-SC connectors with same transmission characteristics as the terminated fibers as defined in Article 2.02.
  2. Fiber optic patch cables shall be supplied in sufficient quantity to connect each active fiber pair at intermediate cross-connect locations identified in the construction documents. Patch cables are not required for spare fibers. Intermediate cross connect locations include the following:
    - a. MDF – cross connect between the MDF and MPOE and MPOP.
    - b. IDF – cross connect between primary backbone and secondary backbone or horizontal fiber.
  3. Fiber optic patch cables shall be OFN type, jacketed with polyvinyl chloride with yellow indicating a single-mode patch cable and orange indicating a 62.5/125 multi-mode patch cable. The cable shall meet requirements of TIA/EIA-568 except for the more stringent requirements on bandwidth and attenuation identified in this Specification.
- H. Fiber Optic Innerduct. Materials: one-inch and/or one and one half inch, orange corrugated with pull rope, rated as required by code.
- I. Category 5E data Cable. Horizontal enhanced Category 5 cabling shall be 24 AWG, four-pair UTP, UL/NEC rated, with appropriately rated PVC (riser) or FEP (plenum) jacket as appropriate to the installation environment and N.E.C. Individual conductors shall be FEP or polyethylene insulated as appropriate to the installation environment. Cables installed in cable trays or on "J"-hooks shall carry a CMP rating regardless of the installation environment. Cable shall meet ANSI/TIA/EIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for four-pair Category 5E cabling as detailed in ANSI/TIA-568-C.2. Category 5E data cabling and patch cables shall be blue or green.
- J. Flooded Category 5E cable for underground applications: Enhanced category 5 cabling shall be 24 AWG, four-pair UTP, UL/NEC rated, with appropriately rated polyethylene jacket with water blocking flooded core. Individual conductors shall be polyethylene insulated. Cable shall meet ANSI/TIA minimum requirements for return

loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for four-pair Category 5E cabling as detailed in ANSI/TIA-568-C.2.

- K. Category 5E Inserts. Category 5E data inserts shall be wired to the T568B wiring pattern. Category 5E data inserts shall meet ANSI/TIA/EIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for Category 5E connecting hardware as detailed in ANSI/TIA/EIA-568. Category 5E data inserts shall be blue or green in color as consistent with the cable jackets for this system.
- L. Exterior Category 5E data drops shall be embedded in an environmentally sealed enclosure with an IEC NEMA 6 rating for Protection from live or moving parts, dust, and protection from immersion in water) and with an ADC 110 punchdown contacts for field termination of horizontal backbone cable of specified length. The connector shall combine existing RJ-45 connector technology with weatherproof housing assemblies and shall be compatible with standard Category 5E RJ-45 connectors. The exterior Category 5E connector shall interlock with exterior patch cord as described in paragraph 2.02.N of this Specification, and provide a seal with a NEMA 6 rating. Category 5E data inserts shall be wired to the T568B wiring pattern. Category 5E data inserts shall meet ANSI/TIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for Category 5E connecting hardware as detailed in ANSI/TIA-568-C.2.
- M. Category 5E Patch Cords. Patch cords shall be Category 5E rated, 24 AWG, four pair assemblies. Patch cords shall be factory assembled by the manufacturer of the cabling system. LAN Patch cords shall be the same color, blue, or green as the cabling system. Provide and install Category 5E patch cords as follows:
1. One two-meter Category 5E patch cord for each work area outlet installed.
  2. In the wiring closets, Category 5E patch cords shall be provided in a like manner (one per user port). Patch cords shall be provided in varying lengths to accommodate a patch that can be neatly loomed into the cable management system. In wiring closets and passive patch locations, patch cords shall be installed and shall cross connect structured cabling to LAN equipment ports.
    - a. In LDF locations in cabinets with less than 26 inches of rack space, Patch cables shall be provided in the following distribution of lengths – 30 percent one foot; 40 percent two feet; 30 percent three feet.
    - b. In MDF, IDF, and LDF locations in stand-alone cabinets with between 26 inches and 56 inches of rack space, patch cords shall be provided in the following distribution of lengths – 60 percent one meter; 40 percent two meters.
    - c. In MDF and IDF locations in cabinets with more than 56 inches of rack space, or ganged cabinets, patch cords shall be provided in the

following distribution of lengths – 20 percent one meter; 40 percent two meters; 40 percent three meters.

- N. Category 5E patch cords for exterior locations. The patch cord shall combine existing Category 5E RJ-45 plug technology with weatherproof assemblies and shall be compatible with standard Category 5E RJ-45 connectors. One end of the ten foot patch cord shall be a Category 5E RJ-45 plug embedded in a housing that creates an environmental seal, a strain relief, and a locking mechanism when mated to exterior Category 5E connector, and an ingress protection of NEMA 6. See paragraph 2.02 L of this Specification. The other end of the patch cord shall be a standard Category 5E RJ-45 plug connector.
- O. Category 5E Patch Panels. Patch Panels shall be provided in 24 or 48 port compliments with modular jack ports wired to T568B. Patch panels consisting of 48 ports or less shall not exceed one EIA rack unit in height. Patch panels shall be augmented with cable support bars in rear to properly dress cable. Patch panels shall meet ANSI/TIA/EIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for Category 5E connecting hardware as detailed in ANSI/TIA/EIA-568 Quantity and size of patch panels must be selected to provide 20 percent expansion capacity. One EIA rack unit of horizontal wire management shall be provided adjacent to each patch panel both above and below.
- P. Outlet Gang Boxes. As a minimum, the telecommunications outlet box shall be capable of housing four Category 5E terminations or two terminated optical fibers. The outlet box shall have the ability to secure the optical fiber cable and provide for a minimum fiber bend radius of one inch. Typically, the telecommunications outlet/connector box shall consist of a four inch by four-inch electrical box or surface mount box.
- Q. Weatherproof single gang outlet box shall be NEMA 3R rated, either flush mount or surface mount as shown on the Drawings. The weatherproof single gang outlet box shall be used for mounting exterior Ethernet outlets (See paragraph 2.02.L of this Specification). This outlet box shall be mounted inside a terminal cabinet for exterior Ethernet outlet.
- R. Faceplates. Faceplates shall be constructed of ABS molding compound and have the ability to accommodate one insert.
- S. Exterior faceplate shall be a single gang, two ports, and stainless steel plate. The faceplate shall be pre-punched for mounting use with weatherproof housing assemblies (paragraph 2.02 L.). The faceplate shall be gasketed and have an NEMA 12 rating.
- T. Fiber Faceplates. Fiber faceplates shall be constructed of ABS molding compound and have the ability to accommodate a minimum of two angled duplex multi mode or single mode SC connectors.

- U. Horizontal Cable Management panels shall be 19-inch rack mount with a minimum of four-management rings one-rack unit (1.75 inches) in height. Rings shall not exceed more than 1.75 inches in depth unless otherwise noted in the construction documents.
- V. Floor Standing Cabinet. Floor-standing equipment cabinet for MDF or IDF installation use as required. Cabinet shall provide at least 84 inches (48 EIA/TIA rack units) of total mounting space for 19-inch panels and 36 inches of usable interior depth. If two cabinets are required in an MDF, structured cabling components shall terminate within the same rack with the Backbone Switch. Cabinet shall be constructed of steel with 14-gage carbon steel front and rear adjustable mounting rails tapped for #10-32 screws on EIA spacing front and rear. Cabinet shall be tested and certified to the seismic specifications set forth by NEBS Telcordia Technologies GR-63-CORE. Cabinet shall be provided with a thermostatically controlled heat dissipation fan; textured antique finish; matching side panels and louvered top panel; a hinged, key locking, bronze-tinted acrylic window door in front keyed to Corbin Cat 90; and a full length, hinged, key-locking rear door keyed to Corbin Cat 90. Cooling fan thermostat shall be set at 78 degrees Fahrenheit. When installed, both doors shall be able to swing fully open. Cabinets shall be UL listed.
- W. Wall-Mounted Cabinet. Wall-mounted equipment rack for IDF and LDF locations. IDF cabinet shall provide at least 45 inches of mounting space for 19-inch panels (26 EIA/TIA rack units), a 22-inch main body and a minimum of 24 inches of usable interior depth. LDF cabinet shall provide at least 24 inches of mounting space for 19-inch panels (13 EIA/TIA Rack Units), a 22-inch main body and 24 inches of usable interior depth. Cabinet bodies shall be 14 gage or better, welded steel construction with 14-gage carbon steel front and rear adjustable mounting rails, tapped for #10-32 screws on EIA spacing, fully adjustable front-rear. Allowable deflection of an open cabinet when loaded to its maximum weight capacity, shall not exceed .75 inches (3/4 inches) Wall mount IDF and LDF cabinets shall be configured to have a minimum of 18 inches from front to rear rack-mounting rails. Cabinet shall have factory made top or side ventilation capability and a thermostatically controlled heat dissipation fan rated at no more than 32dBA, a Plexiglas front door, and flush mounted locks on both front and rear sections. The front lock shall be keyed to Corbin CAT 90 and the rear lock shall be keyed to Corbin CAT 90. Cooling fan thermostat shall be set at 78 degrees Fahrenheit. Cabinets shall be provided with white powder coat finish. Cabinets shall be UL listed.

## 2.03 SIGNAL TERMINAL CABINETS

- A. Cabinets shall be code gage galvanized steel or blue steel; fronts, doors, and trim shall be code gage furniture steel. Cabinets shall be furnished with at least six-inch high gutters at top and bottom where feeder cable size exceeds four gage or where feeder cable passes through cabinet vertically. Cabinets shall be furnished with top and bottom gutters sized as required by inspection department having jurisdiction, but never less than six inches where more than one feeder enters top or bottom of cabinets. Side gutters shall not be less than four inches wide. Width of cabinets shall be 20 inches, unless otherwise indicated on Drawings.

- B. Doors shall be cut true, shall accurately fit opening, and finished smooth across joints. Rabbets shall be inside. Door shall be sized as required to permit removal of devices intact. Gutters shall be provided at sides and top of compartment. Hinges shall be entirely concealed except for barrels and pins. Hinge flanges shall be welded to door and trim. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors keyed to Corbin No. 90 keys.
- C. Outdoor cabinets shall be NEMA Type 3R. Construction shall be formed from code gage galvanized steel with ANSI No. 61 gray enamel finish. Provide heavy-duty, three-point latching, vault type door handles with padlocking provisions. Provide stainless steel butt hinges on doors. Padlocks shall be furnished, keyed to Corbin No. 90 keys. Outdoor terminal cabinets shall be used only if approved by the Owner.

## 2.04

## TELEPHONE SYSTEMS

- A. Wiring
  - 1. Telephone Trunk Cables. Cables shall be rated for inside installation, PVC insulated 22 AWG solid conductor cables unless otherwise specified by access provider. Cables shall be available in standard increments of 25, 50, 100, 200, 600, 800, 1,000 and 1,200 pairs. Any cable that exits the building must be rated for exposed environments and graded as outside plant cable.
  - 2. Installed telephone cable terminations, on 110-type terminating blocks, shall be installed in signal terminal cabinets, on  $\frac{3}{4}$  inch plywood backboards, painted using fire-retardant paint. Cables shall be dressed in orderly fashion on entrance to the cabinets, properly secured with cable D-Rings that preclude snagging or inadvertent movement of the cables.
  - 3. Telephone Trunk Cables shall be terminated at the MDF locations using 110 type blocks that meet Category 5E data specifications (i.e., Siemens, or equivalent). Cross connects in the MDF at these blocks will then distribute to interior PVC-jacketed, Riser grade, or outside Plant Grade cables that connect to individual IDF locations, depending on whether IDFs are located in the same building, a different floor, or in a different building.
  - 4. Category 5E Cable, when used to connect voice telephones to the nearest IDF location shall carry the same rating and specifications as listed in the Local Area Data Networking (Article 2.02). Category 5E telephone wiring systems shall use yellow or red-jacketed cable.
  - 5. Flooded Category 5E cable for underground applications. Category 5E Cable, when used to connect voice telephones to the nearest IDF location shall carry the same rating and specifications as listed in the Local Area Data Networking (Article 2.02).

6. Category 5E Inserts. Category 5E data inserts shall be wired to the T568B wiring pattern. Category 5E data inserts shall meet ANSI/TIA/EIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for Category 5E connecting hardware as detailed in ANSI/TIA/EIA-568. Inserts shall be yellow or red in color as consistent with cable color for the system.
  7. Category 5E Patch Cords. Patch cords shall be Category 5E rated, 24 AWG, four pair assemblies. Patch cords shall be factory assembled by the manufacturer of the cabling system. Telephone system patch cords shall be the same color (yellow or red) as the telephone cabling system.
  8. Category 5E Patch Panels. Patch Panels shall be provided in 12, 24 or 48 port compliments with modular jack ports wired to T568B. Patch panels shall be augmented with cable support bars in rear to properly dress cable. Patch panels shall meet ANSI/TIA/EIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for Category 5E connecting hardware as detailed in ANSI/TIA/EIA-568. Quantity and size of patch panels must be selected to provide 20 percent expansion capacity. One EIA rack unit of horizontal wire management shall be provided adjacent to each patch panel both above and below.
  9. Telephone Modular Jacks. Contractor Furnished, Contractor Installed (CFCI):
    - a. Provide modular jacks, eight-position, TIA-568, Category 5E, using T568B wiring pattern. Jacks shall be UL verified and listed, Category 5E with 110 contacts and blue or red in color – whichever is consistent with the system cable sheath color. Provide duplex faceplate mounting straps, where required. Provide wall and floor outlet plates as indicated in Section 26 0513: Basic Electrical Materials and Methods.
- B. Telecommunications Related Equipment:
1. Telephone Type T7. Contractor Furnished, Contractor Installed (CFCI).
  2. Type T7 shall be a modular telephone jack - type RJ-11 - on an independent line, separate from the telecommunications system. Provide independent line modular jacks at Administration fax machines to each elevator room, pay telephones (typically at multipurpose room, gymnasium, and auditorium lobbies), and/or as indicated on Drawings. Each independent line will be terminated at the backboard in the MPOE. Termination of Category 5E cable to an RJ-11 jack shall use the green and green/white conductors for typical tip and ring connections. The green conductor shall be terminated at the jack on the tip side.

### PART 3 - EXECUTION

**3.01 PREMISE WIRING INSTALLATION**

**Site Conditions.** Examine the areas and conditions under which the work of this Section will be performed. Unsatisfactory conditions shall be reported to Owner before the contractor begins work.

**A. Conduit Subsystem:****1. Excavation:**

- a. Call the Owner's Authorized Representative at least 48 hours prior to excavation.
- b. Locate and protect existing construction, plant life, and utilities. Before excavation, contact the "Underground Service Alert of Southern California" (USASC) for information on buried utilities and pipelines.

**2. Inter-building Conduits:**

- a. Provide and install two inner ducts of 1 ½-inch and one inner duct of 1 inch with indexed pull cords.
- b. Ductbanks shall have a continuous slope downward toward ground vaults and away from buildings with a pitch of not less than 4 inches in 100 feet.
- c. Inter-building exterior and underground conduit runs shall not exceed 200 feet and shall not contain more than two bends of 90-degrees or less between pullboxes or vaults. Distances of up to 600 feet between underground pull boxes may be allowed if the conduit run between pull boxes has no bends, and is indicated on Drawings.
- d. Stagger joints of the conduit by rows and layers so as to provide a duct line having maximum strength.
- e. During and after construction, protect partially completed duct lines from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of a duct line is completed from ground vault to ground vault, draw a stiff bristle brush of the proper diameter through each duct until the conduit is clear of particles of earth, sand, and gravel then immediately re-install conduit plugs.
- f. Conduit fill shall not exceed 40 percent.

**3. Intra-building Conduits:**

- a. Interior conduits for multiple cables to communication outlets are to be a minimum of 1 ¼-inch and dedicated conduits shall serve outlet boxes.

- b. No more than six feet of flexible conduit shall be used in any conduit run.
  - 1) Flexible conduit shall not be used in concealed or inaccessible areas such as interstitial wall spaces or hard lid ceilings.
  - 2) Where flexible conduit is used, the conduit fill shall be derated by one trade size.
4. Entrance/Access Provider Conduits:
  - a. Entrance Conduit for Telecommunications:
    - 1) Telecommunications entrance conduits for small and medium size sites less than 100 classrooms shall consist of one, 4-inch trade size) conduit plus one spare of equal size.
    - 2) Telecommunications entrance conduits for large secondary school sites of 100 classrooms or more shall consist of two four inch trade size conduits plus one spare of equal size.
    - 3) Each installed conduit shall be equipped with a 5/16 inch polypropylene pull rope.
    - 4) The primary entrance conduit shall be provisioned with two 1-1/2 inch and one one-inch inner ducts each installed with indexed pull cords, unless AP representative indicates other requirements.
  - b. Entrance conduits for CATV Access Provider
    - 1) CATV entrance conduit shall be one three inch trade size conduit.
    - 2) Each installed conduit shall be equipped with a 5/16 inch polypropylene pull rope.
  - c. Construction of underground duct banks:
    - 1) Construct underground ductbanks of individual conduits encased in concrete. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts.
    - 2) Separate conduits by a minimum concrete thickness of three inches. Provide plastic duct spacers between ducts, at a maximum five feet on center.

- 3) The top of the concrete envelope shall not be less than 24 inches below grade.
- 4) Duct lines shall have a continuous slope downward toward ground vaults and away from buildings with a pitch of not less than four inches in 100 feet.
- 5) Manufactured bends shall have a minimum radius of 36 inches.
- 6) Stagger joints of the conduit by rows and layers so as to provide a duct line having maximum strength.
- 7) During and after construction, protect partially completed duct lines from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of a duct line is completed from ground vault to ground vault or ground vault to building, draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of particles of earth, sand, and gravel then immediately install conduit plugs.
- 8) No underground conduit run, without a pull box, is to be longer than 200 feet and shall contain no more than two bends of 90-degrees or less.
- 9) Pull boxes or ground vaults shall not be used in place of conduit bends.
- 10) Conduit types shall be limited to rigid metal conduit and schedule 40 PVC. Flexible metallic conduit and EMT shall not be used in entrance systems.
- 11) Conduit shall be reamed to eliminate sharp edges and terminated with an insulated bushing.
- 12) Joint trench methods shall not be used in entrance facility duct banks.

d. Ground Vaults and Pull Boxes:

- 1) Ground Vaults and pull boxes shall be installed in paved areas wherever possible. Top of box shall align with finish surface of paving. Wherever possible, install boxes where runoff water will not drain to the box. If vaults or boxes must be installed in an unpaved area subject to runoff, top of box shall be raised to allow no less than one inch of clearance from grade to top of box. In all cases, the top of vault or box shall be at or above the highest point in the runoff area.

- 2) Provide pulling irons on opposite walls and below horizontal centerlines of ducts and cemented openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.
- 3) Install a floor drain into sump containing two cubic yards of crushed rock, minimum size 48 inches deep and 36 inches diameter. Provide a 36-inch length of 6-inch diameter perforated tile pipe extending down into sump and fill with gravel. Cover sump with grille.
- 4) Install ground rod in each concrete pull box. Locate near a wall with six-inch projection above floor for ground clamps. Permanently ground metal equipment cases, cable racks, etc. in pull boxes. Ground conductors shall be #4-0 bare stranded copper.

e. Above grade exterior and interior conduit systems:

- 1) Conduits placed and mounted to exterior and interior portions of a building to extend conduit pathways from the ground vaults to the site's MPOP shall be Rigid Metallic Conduit (RMC).
- 2) Conduits shall be bonded and grounded.
- 3) Securely fasten entrance conduits to the building so they can withstand a typical placing operation performed by the AP.
- 4) Pull boxes, if needed, must be accessible. Do not place pull boxes above fixed ceilings, HVAC ducts, or piping.
- 5) No interior conduit is to be longer than 100 feet between pull boxes, and shall contain no more than two bends of 90-degrees or less.
- 6) Pull boxes shall not be used in place of conduit bends unless site conditions do not allow the use of conduits with data sweeps.
- 7) Where not required elsewhere in District Specification or Code, pull boxes shall be sized per the BICSI TDMM current edition.
- 8) An UL-approved fire stop applicable to the installation must be used when penetrating fire rated walls or floors.

f. Conduit termination in MPOP:

- 1) For conduits entering telecommunications room from below grade point, conduits shall extend four inches above the finished floor.
- 2) For conduits entering from ceiling height conduits shall terminate four inches below the finished ceiling.
- 3) Keep the area around an entrance conduit free of any construction, storage, mechanical apparatus, etc.
- 4) Seal the inside-the-building end of a conduit to prevent rodents, water, or gases from entering the building. Use rubber conduit plugs, a water plug, or duct sealer, depending upon the conditions.

**B. Local Area Network MDFs/IDFs/LDFs:**

1. If backboards are necessary for MDFs, IDFs, and LDFs they are to be  $\frac{3}{4}$ -inch fire-retarding ACX plywood with the A side out and painted with two coats of flat light colored fire-retarding paint on all sides. The size of the backboards will be determined by the size of the building and space provided.
2. Provide an MDF, IDFs, and LDFs at each campus. The MDF shall be co-located, or located as close to the MPOE as practical. IDFs shall be located within the campus buildings and in sufficient quantity to maintain compliance with the horizontal cable running distance limitations as specified in TIA/EIA 568. IDFs will distribute network connections to the classrooms. LDFs will provide connection for the workstations within offices, student nutritional service areas, multi-purpose rooms, computer labs, and libraries.
3. Provide an LDF in each student nutritional service area, multi-purpose room, computer laboratory, and library. LDFs shall consist of a wall-mounted cabinet containing the data switches, Category 5E patch panels, patch cords, connectors, and wire management required to distribute each Category 5E data drop to the workstations located within the room. However, if the LDF is within compliant distance from an otherwise adjacent MDF or IDF cabinet, the LDF may be physically co-located within that MDF/IDF cabinet.
4. MDF cabinets shall normally be installed in a LAN or Information Services room and may be used for support to some local data drops. Provide receptacles, cabling, and pathways to those local drops.
5. MDF/IDF/LDF Category 5E Termination Installation:
  - a. Category 5E patch panels shall be installed in 24 or 48 port complements. Provide and install necessary patch cords, both copper and fiber optic, for internal cabinet interconnections.

- b. One EIA rack unit of horizontal wire management shall be provided adjacent to each patch panel both above and below.
  - c. Cables shall be dressed and terminated in accordance with TIA/EIA-568, manufacturer recommendations, and this Specification.
  - d. Pair untwist at the termination shall not exceed one half inch for Category 5E connecting hardware.
  - e. Bend radius of the cable in the termination area shall not be less than four times the outside diameter of the cable.
  - f. Cables shall be neatly bundled, not overly tight, and dressed to their respective panels or blocks. Cable wraps shall not be tight enough to disturb the internal cable pair twists and positioning.
  - g. The cable jacket shall be maintained as close as possible to the termination point.
  - h. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties.
  - i. Patch cords used at the rack or cabinet shall include single-mode and multi-mode duplex fiber, and Category 5E, 24 AWG, four-pair assemblies, as required.
6. MDF/IDF/LDF Fiber Termination Hardware Installation:
- a. Stripped fiber slack shall be neatly coiled within the fiber termination panel. No stripped slack loops shall be allowed external to the fiber panels. Fiber loops must not be smaller than minimum bend radius of the cable.
  - b. Cables shall be individually attached to the respective termination panels by mechanical means.
  - c. Each fiber cable shall be stripped upon entering termination panels and the individual fibers routed neatly into termination panels.
  - d. Each cable shall be clearly labeled at the entrance to the termination panel.
  - e. Dust caps shall be installed on unused connectors and couplings.
7. Backbone Cabling:

- a. Proper bending radius and pulling strength requirements of cables shall be followed during handling and installation. Cables, splice cases, punch-down frames, LIUs, patch panels, and supporting hardware shall be installed in accordance with manufacturer recommendations.
- b. Outside plant fiber shall be installed in 1 ½-inch or one inch corrugated inner duct installed within the backbone conduit.
- c. Interior innerduct and cable shall be plenum or riser rated, as required by applicable code regulation or standard. Riser rated innerduct as a minimum shall be installed on floor-to-floor fiber optic cabling.
- d. Interior fiber not installed in cable tray, conduit or raceways shall be installed in innerduct. Innerduct installations shall be properly strapped and supported every four feet in concealed spaces only. Innerduct shall be rated for indoor or outdoor use as applicable by code.
- e. Cables in panels, cabinets, trays, and racks shall be neatly grouped and strapped using hook and loop cable straps. Cables shall be placed in a manner that allows equipment installation without rerouting. Full rack rail travel adjustments shall not be impeded by cable installation. Cables and panels shall be clearly identified at both ends with a unique cable numbering system and in compliance with ANSI/TIA 606. Refer to Section 27 0536 for Cable Tray requirements.
- f. When cable runs are being installed, provide additional slack at both ends to accommodate future cabling system changes. The minimum amount of allowable slack at the:
  - 1) MDF shall be ten feet.
  - 2) IDF and LDF shall be three feet.  
Include the slack in length calculations to ensure that the cable does not exceed maximum allowable lengths as defined herein. Do not store slack in bundled loops. Store cable slack in an extended loop or in a figure eight configuration to alleviate stress.
- g. The backbone fiber optic cable shall be installed in configurations based upon the physical topology and logical connections required as follows:
  - 1) If the MDF-to-IDF cabling distance is 450 meters or less:
    - a) The installed cable from MDF-to-IDF shall be a minimum of 12 strands multi-mode and six strands single-mode.

- b) The multi-mode fiber optic strands shall be installed in multiples of six including a minimum of 10 percent spare multi-mode fiber strands after required fiber optic links are connected.
- 2) If the MDF-to-IDF cabling distance is greater than 450 meters:
  - a) The installed cable from MDF-to-IDF shall be a minimum of 12 strands multi-mode and 12 strands single-mode.
  - b) The single-mode and multi-mode fiber optic strands shall both be installed in multiples of six with a minimum of 10 percent spare single-mode and multi-mode fiber strands after required fiber optic links are connected.
  - h. Fiber optic strands shall be terminated and no fiber cable shall be spliced.
  - i. Cable shall be installed in accordance with manufacturers' recommendations and best industry practices.
  - j. Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type.
  - k. Cables shall be installed in continuous lengths from origin to destination with no splices.
  - l. The cable's minimum bend radius and maximum pulling tension shall not be exceeded.
  - m. Replace any cable damaged or subjected to installation practices outside of those specified within this document.
- 8. Secondary Backbone Cable:
  - a. Fiber distribution cable for data circuits from IDFs to LDFs shall be four or six strands of fiber optic cable, CMP or CMR rated as required. Secondary Backbone cables shall not exceed 90 meters in length.
    - 1) If the MDF-to-IDF cabling distance is 450 meters or less, the installed horizontal fiber cable for the computer labs, libraries, classrooms, and other LDF locations shall be a minimum of four strands multi-mode fiber including 10 percent spare capacity rounded up to an even number of strands, terminating on duplex SC network drops. Network drops shall be collocated within the LDF installation - described in this Specification.

- 2) If the MDF-to-IDF cabling distance is greater than 450 meters, the installed horizontal fiber cable for the computer labs, libraries and other LDF locations shall be a minimum of four strands single-mode fiber including 10 percent spare capacity rounded up to an even number of strands, terminating on duplex SC network drops. Network drops shall be collocated within the LDF installation - described in this Specification.
- 3) Fiber cable shall be installed in conduit, cable tray, raceways, or in innerducts when installed in J-hooks. No cable shall be installed laying on ceiling tile. Cable supports shall be installed to independently carry the cable without pinching or crimping the cable in any way. Vary the spacing of supports to prevent frequency dependent aberrations. Fiber hung on J-Hooks shall be installed in innerduct, with proper supports every four feet.
- 4) Cable shall be installed in accordance with manufacturers' recommendations and best industry practices.
- 5) Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type.
- 6) Cables shall be installed in continuous lengths from origin to destination with no splices.
- 7) When cable runs are being installed, provide additional slack at both ends to accommodate future cabling system changes. The minimum amount of allowable slack at the:
  - a) MDF shall be ten feet.
  - b) IDF and LDF shall be three feet.
  - c) Include the slack in length calculations to ensure that the cable does not exceed maximum allowable lengths as defined herein. Do not store slack in bundled loops. Store cable slack in an extended loop or in a Figure 8 configuration to alleviate stress.
- 8) The cable's minimum bend radius and maximum pulling tension shall not be exceeded.
- 9) J-Hook or trapeze system shall be used only if shown on drawings to support cables in dropped ceiling spaces. J-Hooks shall not be used to distribute optical fiber cables within classrooms. Horizontal optical fiber cables distributed using J-hooks shall be placed in innerduct. Horizontal cables shall be supported at a maximum of three-foot intervals and shall be in

full compliance with the Codes and Standards as listed in Article 1.04 of this Specification.

- a) Cable(s) shall not rest on or attach to acoustic ceiling grids or panels.
  - b) Cable shall be installed above fire-sprinkler and other mechanical systems and shall not be attached to the system or any ancillary equipment or hardware.
  - c) Cables shall not be attached to ceiling grid or lighting support wires.
- 10) Replace any cable damaged or subjected to installation practices outside of those specified within this document and the Codes and Standards listed in Article 1.04 of this Specification.

9. Horizontal Cabling:

- a. Optical fiber distribution cable for horizontal data circuits from IDFs to classrooms, libraries, and other instructional areas shall be four strands of multi-mode fiber optic cable, CMP or CMR rated as required. Fiber optic horizontal cables shall not exceed 90 meters in length. Horizontal Fiber terminations will be made as follows:
  - 1) If an LDF is specified – Each four or six strand fiber optic cable shall be terminated on a modular rack mount patch panel which combines connectivity for both the fiber, using duplex SC connectors, and Category 5E, using RJ-45 connectors.
  - 2) When wall jacks are specified - Each four-strand fiber optic cable shall be terminated on a dual SC, duplex outlet with angled connectors at the work area. Associated faceplates shall accommodate both duplex, SC connector outlets.
- b. Copper Horizontal distribution cable shall be TIA/EIA-568, Category 5E, four-pair unshielded twisted pair, and CMP or CMR rated cable, as required. Each Category 5E cable shall be terminated on an eight-position, eight-conductor Category 5E jack (at the workstation locations) or patch panel (in the MDF/IDF/LDF). Terminations shall be wired in accordance with T568B. Associated faceplates shall accommodate four jacks. Quantities of cables to each outlet shall be in accordance with the location type and project document.
  - 1) Cable shall be installed in accordance with manufacturers' recommendations and best industry practices.

- 2) Copper horizontal cable shall not exceed 90 meters in length.
  - 3) Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type.
  - 4) Cables shall be installed in continuous lengths from origin to destination (no splices or cross-connects are permitted).
  - 5) The cable's minimum bend radius and maximum pulling tension shall not be exceeded.
  - 6) Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cable outside diameter.
  - 7) When cable runs are being installed, provide additional slack at both ends to accommodate future cabling system changes. The minimum amount of allowable slack at the:
    - a) MDF, IDF or LDF will be three feet.
    - b) Work Area Outlets will be 12 inches.
  - 8) J-Hook or trapeze system shall be used only if shown on drawings to support cables in dropped ceiling spaces. Horizontal optical fiber cables distributed using J-hooks shall be placed in innerduct. Horizontal cables shall be supported at a maximum of three-foot intervals and shall be in full compliance with the Codes and Standards as listed in Article 1.04 of this Specification.
    - a) Cable installed above fire-sprinkler systems shall not be attached to the system plumbing or any ancillary equipment or hardware.
    - b) Cables shall not be attached to ceiling grid or lighting support wires.
  - 9) Pulling tension on four-pair UTP cables shall not exceed 25 pounds for a single cable or cable bundle.
  - 10) Replace, before terminations are completed, cables damaged or subjected to installation practices outside of those specified within this document, at Installer's expense.
- c. The following identifies the minimum number of Category 5E and fiber drops to be installed into each area identified. Additional areas and additional drops may be required and will be identified on the project

documents. Cable and termination requirements are identified in Article 2.02 of this specification.

- 1) Standard office, workstation, or cubicle will receive three Category 5E drops in a single four-position faceplate. Two Category 5E drops will be marked for Data, the other for Voice. Empty openings on faceplates shall be effectively closed using factory made blank inserts.
- 2) Administrative office core areas shall receive three Category 5E drops in a single four-position faceplate per user or desk indicated on the drawings. Two Category 5E drops will be marked for Data, the other for Voice. Empty openings on faceplates shall be effectively closed using factory made blank inserts.
- 3) Conference rooms will receive up to eight Category 5E drops; four each at two separate locations in the room. Each group of four drops will terminate in a single faceplate with two Category 5E indicated for Voice and two for Data. Empty openings on faceplates shall be effectively closed using factory made blank inserts.
- 4) Classroom:
  - a) A minimum of one four-strand fiber drop to the teacher's drop in the classroom.
  - b) A minimum of five student Category 5E drops, one Category 5E drop for a printer, and one Category 5E drop at the teacher's location. Category 5E drops shall terminate on two-port faceplates. Empty openings on faceplates shall be effectively closed using factory made blank inserts.
    1. For High Schools provide an additional Category 5E student drop.
- 5) Library: A minimum of one four-strand fiber drop to the LDF in the library and a minimum of 12 Category 5E data drops distributed from the LDF. Larger libraries shall be provided with up to 20 drops. Category 5E drops must be grouped with two Category 5E jacks (and two blank jacks) per faceplate. Drops must be distributed within the room according to the Project documents. Empty openings on faceplates shall be effectively closed using factory made blank inserts.

- 6) Computer Laboratories: A minimum of one (1), six-strand fiber drop to the LDF in the computer laboratory and 40 Category 5E data drops distributed from the LDF. Category 5E drops shall be grouped with up to six Category 5E jacks per faceplate. Empty openings on faceplates shall be effectively closed using factory made blank inserts. Drops must be distributed within the room according to the Project documents.
- 7) Student Nutritional Support Areas: one, four-strand fiber drop to the LDF and up to 20 Category 5E data drops distributed from the LDF. Category 5E drops must be grouped with two Category 5E jacks and two blank jacks per faceplate. Empty openings on faceplates shall be effectively closed using factory made blank inserts. Drops must be distributed within the room according to the Project documents.
- 8) Student Nutritional Support Areas - Exterior Locations: Each location shall receive two Category 5E drops in an environmentally sealed enclosure as described in paragraph 1.02 B. 4 of this specification.
- 9) Multi-purpose rooms shall contain a total of: one, 4-strand fiber drop and 8 Category 5E data drops distributed from the closest LDF or IDF location. Category 5E drops must be grouped with two Category 5E jacks per faceplate. Empty openings on faceplates shall be effectively closed using factory made blank inserts. Drops must be distributed within the room according to the Project documents and consistent with the descriptions below.
  - a) In the stage area of a multipurpose room, there shall be two Category 5E drops and one, four-strand, multimode fiber optic drop located either at stage apron or the proscenium arch.
  - b) On the other three walls of the multipurpose room, two Category 5E data drops shall be evenly distributed and installed.
- 10) Additional non-instructional and office work area horizontal fiber and Category 5E cabling requirements will be indicated on the Project documents.

10. Labeling and Marking:

- a. Provide complete cable location chart and as-built documentation in an envelope and attach to the inside rear doors of distribution frame cabinets in wiring spaces.
- b. Mark distribution panels, cables, and cover plates with computer-generated labels. Drops shall be labeled with the same identifier on the receptacle faceplate, inside each junction box, on the cable at the jack, on the cable at the patch panel, on the termination side of the patch panel, and on the patch side of the patch panel. Cable markers shall be located within two inches of the end of the cable jacket and shall be directly readable. Panel labels shall be computer-generated and printed using a laser printer. A disk with the label files shall be submitted as part of the project record documents.

C. Racks/Cabinets

1. Racks and cabinets shall be bolted to the floor or wall mounted, as required, and provided with tip bars and additional accessories required for a complete functional system. Racks and cabinets shall be seismically braced and attached to horizontal ladder racking or cable tray with  $\frac{3}{4}$  inch threaded rod.
2. MDF/IDF cabinets shall be placed to accommodate 36-inch aisles in the front and rear. When wall mounted, cabinet placement shall allow a minimum of 31 inches clear on each side and 36 inches in front.
3. Provide CAT 90 keys and locks for cabinets and equipment enclosures. The manufacturer and part number shall be Corbin Russwin part number 5865-JVR or ILCO part number S1000V or equal. The locks and keys shall have a 53315 lock/key code.
4. Where backboards are used for mounting IDFs, and LDFs, they are to be  $\frac{3}{4}$  inch plywood, ACX grade surface with the "A" side exposed and painted with two coats of flat light, colored fire-retarding paint on all sides. The size of the backboards will be determined by the size of the space provided. Cut edges of plywood shall be sanded smooth.
5. Unused openings in cabinets shall be effectively closed.
6. Cabinet doors shall close without striking installed components.
7. Cabling in cabinets shall be installed and loomed in a manner that allows full travel in rack rail adjustment. Cabling shall not infringe on space used for equipment mounting.
8. Cabinets shall be grounded as specified in Article 250 of the California Electrical Code.

9. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.
10. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
11. Maintain the required bending radius of conductors inside the cabinet.
12. Clean the cabinets of foreign material such as cement plaster and paint.
13. Distribute and arrange conductors neatly in the wiring gutters.

D. Telephone Systems:

1. Terminals, Cabinets, and Racks: Telecommunications system and auxiliary cabinets/racks shall be installed and wall-mounted in accordance with CBC seismic requirements and shall not block any existing removable panels or swing-open doors required for normal system expansion or service.
  - a. Terminal Blocks: See appendix 3 for typical network diagram:
    - 1) Furnish terminal blocks in terminal cabinets/racks, and where indicated on Drawings, as required to provide a termination for conductors in communication cabinets/racks and backboards.
    - 2) Terminal blocks shall be 110 Series, solder-less, push-on type, solid, and 22 - 26 AWG. Terminals for connections to external circuits shall be properly labeled. Terminal blocks shall be installed on mounting legs and installed within cabinets/racks as required. Terminal blocks shall be installed on inside back of cabinets/racks only, not on side. Cross-connect and wire management shall meet or exceed TIA/EIA-568, Category 5E performance standards. Terminal blocks shall be pairs of 25 or 100 with mounting legs.
  - b. Terminal Cabinets/racks:
    - 1) Lines and cables within cabinets/racks and on main terminal backboards shall be secured with cable straps. Cables shall be formed in rectilinear configuration. Insulation between conductors and ground shall be properly maintained. Cables shall be properly numbered in numerical order and shall maintain the same numbering system throughout the Project site.
    - 2) Conductors shall be color-coded per EIA/TIA 568 standards. Individual cables shall be run out and tagged with laser-printed

cable markers. Cable index strips shall be typed and installed on terminal cabinet door. Index strips shall be covered with clear plastic adhesive covers. Terminal cabinet cable codes shall be typed on record drawings.

- 3) Terminations and connections shall be on 110 Series blocks. Cables shall be identified as to buildings and rooms served and terminated in terminal cabinets/racks and backboards.
  - 4) Cables to PA system consoles and amplifier inputs shall terminate on 110 Series blocks where PA system is required.
  - 5) Cables from PA consoles and amplifier outputs shall terminate on 110 Series blocks.
  - 6) Cables to telecommunications switches, trunk inputs, shall terminate on 110 Series blocks.
  - 7) Cables from telecommunications switches (extensions, consoles, night bells, etc.) shall be terminated on 110 Series blocks. Provide blocks and cables for maximum possible system configuration.
  - 8) Cables to satellite terminal locations and classrooms shall be terminated on 110 Series blocks. Provide blocks as needed, plus two vertical rows for future expansion, at main cross-connect locations only.
2. Wiring: Wiring within communication cabinets/racks and backboards shall be installed to conform to ANSI/TIA-568-C, Category 5E performance standards, and shall be terminated on terminal strips for required external connections. Wiring shall be cabled, laced, and securely fastened in place so that weight is not imposed on equipment, controls, switches, or terminals. Input circuits and terminal strips shall be installed to provide separation necessary for proper operation. Wires shall be identified by number and chart, and 120VAC wiring shall be in a required conduit or raceway.
  3. Cables: Discussion of cable terminations and location of blocks are subject to provisions of the Terminal Signal Cabinet section above.
    - a. Install conductors and cables to devices indicated on Drawings. Provide conductor terminations to devices for complete telecommunications system to function as specified and as indicated on Drawings.
    - b. Cable runs shall be continuous, no splicing shall be allowed. Terminations shall be in communication cabinets/racks or on telephone backboards. Connections from incoming to outgoing shall be provided

with cross-connect wires. Cables shall not directly connect to other cables.

- c. Conductors and cables shall be installed within conduits, cable trays, boxes, raceways, and cabinets/racks in a manner, which shall provide an enclosed installation, except where otherwise specified. Furnish and install conductors to connect incoming and outgoing circuits, including spare conductors, to terminal strips in the LAN or telephone equipment room, in accordance with TIA/EIA 569.
- d. Cables and four-pair wires shall be behind 110 Series blocks in space created by stand-offs and shall be neatly laced and securely bundled.

### 3.02 RELATED SYSTEMS INSTALLATION

#### A. Telephone Systems:

- 1. Coordination of Installation of Telecommunication Systems:
  - a. Work, including installation or removal, will be coordinated with the OAR. The Contractor shall be responsible for floor plans for cutover, station reviews, and cut sheets. Installer will also provide a complete and detailed scope of work prior to commencement of any implementation.
  - b. If the scope of the Work includes the extension and replacement of an existing telephone system, the cutover and station review must be coordinated with the OAR prior to implementation and every effort must be made to minimize interruption of service during the cutover or at any other time.
  - c. Examination:
    - 1) The Inspector shall observe installation of main cable runs. Notify the Inspector not less than two days in advance of proposed time of installation.

### 3.03 CERTIFICATION AND TESTING

- A. Provide the Owner's Authorized Representative (OAR) with copies of factory calibration certificates for each test set used in the testing procedures. Test equipment used shall have been factory calibrated within the previous 12 month period. Operators of the test equipment shall have factory training in the use of the equipment and its software. Cables and termination hardware shall be 100 percent tested for defects in installation and to verify cable performance under installed conditions. Conductors of each installed cable shall be verified useable prior to system acceptance. Defect in the cabling system installation including, but not limited to, cable, connectors, feed through couplers, patch panels, and connector blocks shall be

repaired or replaced in order to ensure 100 percent usable conductors in cables installed.

B. Local Area Network:

1. Copper:

- a. Each cable shall be tested for continuity on all pairs and conductors.
- b. Enhanced Category 5E data cable shall be performance verified using an automated test set for Category 5E link configurations.
- c. Test set shall be certified Level IIE. To ensure verifiable equipment calibration, the Owner shall require field calibration each time a new set of tests are performed. Test for the continuity parameters defined above, and provide results for the performed tests. This test set shall be capable of testing for the continuity and length parameters defined above, and provide results for the following tests:
  - 1) Attenuation.
  - 2) Wire Map.
  - 3) Attenuation to Crosstalk Ratio ACR.
  - 4) Pair-to-pair NEXT loss.
  - 5) PSNEXT loss.
  - 6) Return Loss.
  - 7) Pair-to-pair ELFEXT.
  - 8) PSELFEXT.
  - 9) Propagation delay.
  - 10) Delay skew.
  - 11) Cable length.
- d. Cable length shall be tested using the cable manufacturers' published Nominal Velocity of Propagation (NVP) parameter. Owner's Quality Assurance Agent shall verify the NVP setting prior to commencement of the testing process. Generic settings not using the published NVP parameter will not be accepted.

- e. Test results shall be automatically evaluated by equipment, using the most up-to-date criteria from the ANSI/TIA-568-C standard and the results shown as pass/fail.
  - f. Test results shall be printed directly from the test unit in native format, and both hard and soft copies in native format shall be provided to the Owner. The printed test results shall include tests performed, the expected test result, and the actual test result.
2. Fiber Optics:
    - a. Terminate, test, and document multi-mode and single-mode fiber optic cables with approved connectors at the drop locations and on approved fiber optic patch panels at the MDF, IDFs, and LDFs. No fiber optic cables shall remain un-terminated.
    - b. Fiber optic cables shall meet EIA/TIA performance standards and shall be tested in accordance with applicable standards. Light source and power meter tests shall be dual wavelength and shall be tested in both directions at each wavelength on each fiber strand. Optical time domain reflectometer (OTDR) tests shall be performed with an instrument suitable for testing campus cable plants. OTDR tests shall be conducted at both wavelengths from the MDF with sufficient launch cables installed at both ends of the fiber run to clearly identify the mated connectors. OTDR launch and landing cables shall not be less than 100 meters in length. The light pulse duration used shall not be greater than 50 nanoseconds. Sampling resolution shall not be less than five feet per 100 meters.
      - 1) Multi-mode fiber optic cable runs shall be tested in both directions at each frequency with a power meter and light source combination that can verify distance and attenuation. Wavelengths tested shall include 850nm and 1300nm.
      - 2) Single-mode fiber optic cable runs less than or equal to 200m shall be tested in both directions at each frequency with a power meter and light source combination that can verify distance and attenuation. Wavelengths tested shall include 1310nm and 1550nm.
      - 3) Single-mode fiber optic cable runs greater than 200m shall be tested with a power meter and light source combination and with an OTDR. Wavelengths tested shall include 1310nm and 1550nm.
  3. Completion: Work for the installation shall be considered complete after the following have been accomplished:

- a. System testing has been completed. Certify that system is in working order. Cable Test Forms and equipment-specific test documentation, both electronic files and paper records, have been submitted to the Owner.
  - b. Ceiling panels previously removed have been put back in place.
  - c. System labels have been put in place.
  - d. Construction debris and scrap materials have been removed from project site.
  - e. Marked up, project record documents have been returned to the Owner.
  - f. Unused customer material has been returned to the Owner.
  - g. The Owner has successfully completed acceptance testing of the network wiring installation.
  - h. The Owner's Inspector has inspected and accepted the installation.
- C. Signal Terminal Cabinets:
- 1. Cabinets will be securely bolted to the floor and the wall or ceiling as required by seismic requirements.
  - 2. Cabinet will be serviceable and lockable.
- D. Telephone Systems:
- 1. Provide test and reception gear to test for specified performance.
  - 2. For multi-pair copper communications cable, test pairs within counts and binder groups to ensure that no less than 99 percent of the pairs of a multi-pair cable achieve continuity and operation in voice band tests. For Category 5E copper cable, test and certify 100 percent of drops for using test equipment certified for 10/100 validation and operation.
  - 3. For category 5E cabling, requirements of paragraph 3.03 B above.
  - 4. Before Substantial Completion, submit test results and related documents to the Inspector.

### 3.04 PROJECT RECORD DOCUMENTS

A. As-Built Documentation

- 1. Block diagrams indicating items and their point-to-point connections in a manner following floor plan layout.

B. Operating and Servicing Manuals, Record Drawings:

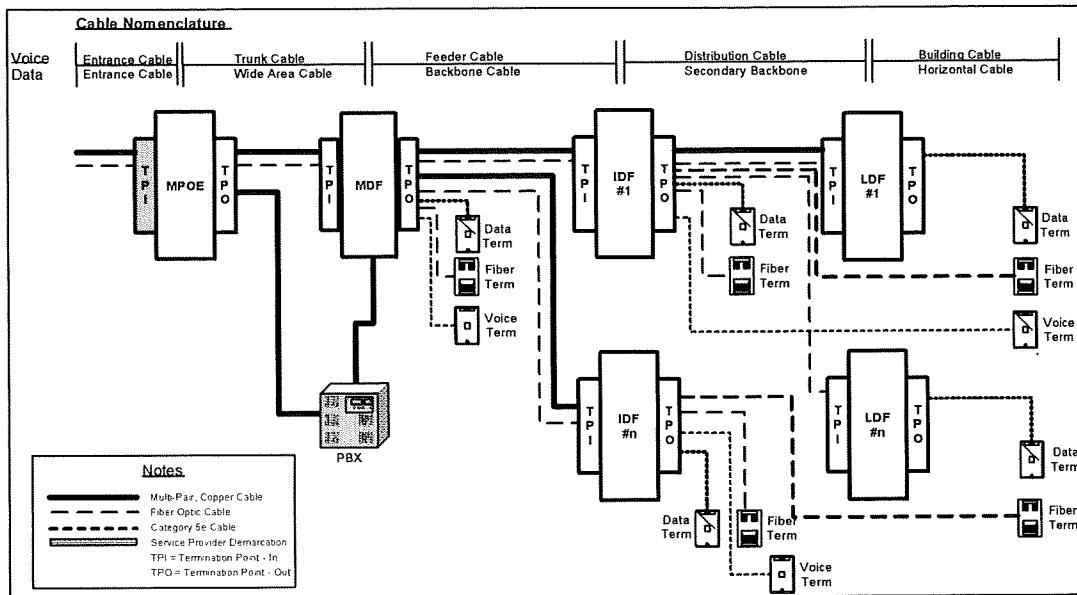
1. Deliver three copies of operating, specification descriptions, and/or service manual. Each complete manual shall be bound in a three ring binder, and data shall be typewritten or drafted.
  - a. Manuals shall include a page with Project site and Project name, date of Substantial Completion, Contractor name, address, telephone, and fax numbers.
  - b. Manuals shall contain a letter, signed by an officer of the company indicating the beginning and ending date of any warranties described in Article 1.07 of this specification and shall describe the company's commitment to service the warranty during the terms specified.
  - c. Manuals shall include specifications and instructions necessary for proper operation and servicing of system.
  - d. Manuals shall include installation and coordination drawings specifically related to this section shall be included as follows:
    - 1) Size A (8 ½ by 11) and size B (11 by 17) shall be bound into the manual.
    - 2) Larger drawings shall be folded and inserted into transparent envelopes and bound into the manual.
2. Deliver two copies of Record drawings on labeled CDs (Compact Disks) representative of the work performed shall be presented at completion of work in the most recent Autodesk's AutoCAD format (.dwg), for Microsoft Windows.
  - a. The submittal shall contain systems wiring installed including telephone, LAN, and any other low voltage system Contractor-installed wiring.
  - b. The submittal shall consist of two electronic copies on CD-ROM and three paper record copies on no less than "E" size drawings, presented prior to the acceptance inspection.
  - c. Owner utilizes layers as a key tool in controlling visibility of drawing elements and to provide consistent information between drawings, yet provide control over what is seen on each sheet. Premise wiring shall be shown on a separate layer, labeled as "Premise Wiring" that uses both building floor plans and conduit supporting structure layers below. The use of any version control blocks or company logos shall be on a layer separate from the premise wiring as-built drawings.

- d. AutoCAD, electronic files supplied shall be multi-layer drawings with the following layers as a minimum:
  - 1) Layer 1 shall contain title blocks only.
  - 2) Layer 2 shall contain building or site plan backgrounds only.
  - 3) Layer 3 shall contain terminal cabinets, devices, cabling, and other system components.

C. Cable Numbering Records:

1. Owner requires both labeling and record documentation at the conclusion of each cable installation project. Labels and cable records allow the Owner to locate, identify, and diagnose cases of trouble more efficiently. They are required for each cable installation project regardless of size and scope.
  - a. Installation, provide a cable management spread sheet that shall include the following:
    - 1) Cable Schedule.
    - 2) Cable Test Forms.
    - 3) Cable Labels.
    - 4) Network planning chart.
  - b. Present the data in an Excel spreadsheet that will operate on Windows XP or Windows 7 platforms. Information shall be presented in paper and electronic forms in a format that will be provided by the Owner.
  - c. A paper copy of the cable schedule in a transparent plastic sleeve shall be affixed to the front door of each Intermediate and Local Distribution Frame (IDF and LDF). In the MDF cabinet, the cable schedule shall be affixed to the rear door of the cabinet.
2. The following information is provided to assist architects, engineers, and installation contractors in understanding and complying with the requirements of this specification. Owner's cable numbering is based on a defined format which readily identifies cable type, and allows maintenance technicians to determine originating and terminating locations by means of cable labels, as required in other sections of the specification.
3. Figure 3-1 below provides a diagram describing functional cabling and network connection elements that have been standardized by the Owner. This cable information is consistent with, but exceeds, the requirements as contained in EIA/TIA Specification 606. Terminating Points In (TPI) and

Terminating Points Out (TPO) may be 110-Type blocks, 110-Type blocks, 24 or 48 density RJ-45 Patch Panels, or Fiber Optic Patch Panels. Termination point equipment is not part of cable records.



**Figure 3-1 - Functional Cabling and Network Connection Elements**

4. Each cable sheath shall be identified by laser-generated labels, and on the cabling record document (see attachment 3) by means of a nine-digit alpha/numeric number. In addition to the nine-digit sheath/cable number, provide three-digit, numeric pair/strand-numbering information specific to each cable/sheath number. The pair/strand number will be documented in the cable record document (attachment 3). The following provides the definition and use of each field.

Cable Number												Pair/Strand Number			
A	A	N	N	N	N	N	N	N	-	N	N				

#1 - Cable Definition	#2 - Cable Type	#3 - Destination No.	#4 - Destination No.	#5 - Destination No.	#6 - Cable Number	#7 - Cable Number	#8 - Cable Number	#9 Reserved	#10 Pair/Strand Number	#11 Pair/Strand Number	#12 Pair/Strand Number
-----------------------	-----------------	----------------------	----------------------	----------------------	-------------------	-------------------	-------------------	-------------	------------------------	------------------------	------------------------

A=alpha characters only; N=numeric character only

5. The following are the permissible characters that may be entered into each field.
- Cable Definitions (Field #1):
 

T	Trunk – Voice from MPOE to MDF
W	Wide Area – Data from MPOE to MDF
F	Feeder – Voice from MDF or PBX to IDF
B	Backbone – Data from MDF to IDF
D	Distribution – Voice IDF to LDF (see note below)
S	Secondary Backbone – Data IDF to LDF
B	Building cable drops – Voice IDF to User Jack
H	Horizontal – Data IDF, or LDF to User Jack
  - Cable Types (Field #2):
 

C	Multi-pair copper cable
F	Multi-pair fiber optic cable
  - Destination Number (Fields #3-4):
 Fields 3 -- 5 taken together will be a three-digit sequential number identifying the IDF, or LDF destination. The first digit of this destination number (field #3) will be structured to identify whether the destination is an IDF or LDF using the following convention:
    - IDFs are identified in field #3 by the numbers “0” through “1”.
    - LDFs are identified in field #3 by the numbers “2” through “3”.
    - The numbers “4” through “9” are reserved for future use.
    - For each situation, fields #4 and #5 will be a sequential number identifying unique, specific IDF or LDF locations.
 By this convention, each IDF or LDF will be represented by a unique three digit number; IDFs will be numbered in the range 000—199 and LDFs will be numbered in the range 200—399.
  - Cable Number (Fields #6-8):
 This will be a unique and sequential three digit number assigned to each cable sheath.
  - Field #9 is reserved and will be represented using a dash “-“.
  - Pair/Strand Number (Fields #10-12):
 This will be a unique and sequential three digit number for each copper cable pair or fiber strand within a sheath.

Note: Code “D” in the Cable Definition Field is a non-standard cable configuration and normally not used. Owner serves voice jacks directly

from IDFs. The Owner must approve, in advance of construction or installation, any installation that brings voice communications through an LDF.

**3.05 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**3.06 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**3.07 OWNER ORIENTATION**

- A. Completed shop drawings, as specified in Article 3.04 above shall serve as the Owner's orientation.

**END OF SECTION**

## APPENDIX 1 – ACRONYMS

ANSI	American National Standards Institute
BICSI	Building Industry Consulting Services, International
CESM	Compact Edge Switch-Managed
CLDF	Classroom Local Distribution Frame
EIA	Electronic Industries Alliance
ESM	Edge Switch-Managed
FEP	Fluorinated Ethylene Propylene
HVAC	Heating, Ventilation, and Air Conditioning
IDF	Intermediate Distribution Frame
IEC	International Electrotechnical Commission (IP Code)
IEEE	Institute of Electrical and Electronic Engineers
IP32	Degree of Ingress Protection Provided by Enclosures (IEC)
IP	Internet Protocol
IPX	Inter-network Packet Exchange
ISA	Industry Standard Architecture
ISDN	Integrated Services Digital Network
ISM	Intermediate Switch-Managed
ISP	Internet Service Provider
ITD	LAUSD, Information Technology Division
LAN	Local Area Network
LAUSD	Los Angeles Unified School District
LDF	Local Distribution Frame
LIU	Light Interconnection Unit
MDF	Main Distribution Frame
MDF-BBS	Main Distribution Frame Backbone Switch
MPOE	Minimum Point of Entry
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
OAR	Owner Authorized Representative
OFNR	Optical Fiber Non-Conductive Riser
OTDR	Optical Time Domain Reflectometer.
PA	Public Address
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories Inc.
UTP	Unshielded Twisted Pair
WAN	Wide Area Network

END OF APPENDIX 1

## APPENDIX 2 – DEFINITIONS

BBS	The Backbone Switch that serves as the central point of network termination, and provides network connectivity to IDFs, computer labs, student nutritional service areas, and libraries.
ISM	The Intermediate Switch–Managed serving as the network termination point for horizontal cabling to classrooms and other areas excluding computer labs and libraries.
ESM	The Edge Switch–Managed serving as the network termination point for horizontal cabling within computer labs, student nutritional service areas, and libraries.
CESM	The Compact Edge Switch-Managed and is a small form factor network access point within the classroom or other designated area for network connections.
MDF	The structure that serves as an entrance facility or main cross-connect, serving the building or campus.
IDF	Located between the MDF and the LDFs and provides a network access point for horizontal fiber cabling.
LDF	A wall-mounted cabinet that serves as the termination point for Category 5E cabling within the room/area in a computer lab, student nutritional service area, or library.

END OF APPENDIX 2

## APPENDIX 3 – CABLE RECORD DOCUMENT

Cable Installation Record

Page: # of #

Project Name:

Date Work Completed:

Installation Contractor:

Inspected by:

Cable										Strand/Pair			Termination
#1	#2	#3	#4	#5	#6	#7	#8	#9		#10	#11	#12	Room Number
T	C	0	0	1	0	0	1	-		0	0	1	
								-		0	0	2	
								-		0	0	3	
								-		0	0	4	
								-		0	0	5	
								-		0	0	6	
								-		0	0	7	
								-		0	0	8	
								-		0	0	9	
								-		0	1	0	
								-		0	1	1	
								-		0	1	2	
								-		0	1	3	
								-		0	1	4	
								-		0	1	5	
								-		0	1	6	
								-		0	1	7	
								-		0	1	8	
								-		0	1	9	
								-		0	2	0	
								-		0	2	1	
								-		0	2	2	
								-		0	2	3	
								-		0	2	4	
								-		0	2	5	
T	C	0	0	1	0	0	2	-		0	0	1	
								-		0	0	2	
								-		0	0	3	
								-		0	0	4	
								-		0	0	5	
								-		0	0	6	
								-		0	0	7	
								-		0	0	8	
								-				•	
								-				•	

LAUSD - Cable Record (Revision 1b - 06/01/06)

111001

**END OF APPENDIX 3**

INSTALLATIN OF 7 RELOCATABLE BUILDINGS  
BIRMINGHAM COMMUNITY CHARGER HIGH SCHOOL

10/01/2011  
STRUCTURED CABLING (EXISTING SITES)  
27 1013-50

## SECTION 27 1018

### LOCAL AREA NETWORK (LAN) SYSTEMS FOR INSTRUCTIONAL LOCATIONS AND SMALL/MEDIUM OFFICE LOCATIONS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes: All equipment provision, preparations, installation, hardware and software, integration, configuration, testing, training, documentation, standards, and acceptance criteria for 10 Gigabits per second (Gbps) fiber optic backbone and Power-over-Ethernet 10/100/1000 Base-T switched Ethernet LAN systems.
- B. The system shall consist of local area network and wide area network / Metropolitan Area Network connectivity equipment, Unshielded Twisted Pair and fiber optic switches providing connectivity for local data ports to the fiber backbone. Devices connected to the cabling system, through various network interface cards, shall be Windows, Apple (Mac), and other computers and printers, servers, copiers, etc.

##### 1.02 RELATED SECTIONS

- A. Applicable Division 01 sections
- B. Section 00 7000: General Conditions
- C. Section 01 7700: Contract Closeout
- D. Section 21 2323: Excavating, Backfilling and Compacting for Utilities
- E. Section 06 1000: Rough Carpentry
- F. Section 26 0500: Common Works Results for Electrical
- G. Section 26 0513: Basic Electrical Materials and Methods.
- H. Section 26 0526: Grounding and Bonding
- I. Section 26 0533: Raceways and Boxes Fittings and Supports.
- J. Section 26 2416: Panelboards and Signal Terminal Cabinets
- K. Section 27 0126: Test and Acceptance Requirements for Structured Cabling
- L. Section 27 1013: Structured Cabling - existing construction
- M. Section 27 1017: Wireless Local Area Networks (WLAN)
- N. Section 27 5116: Public Address and Intercommunication Systems

##### 1.03 CODES AND STANDARDS

- A. Comply with current versions of the following applicable codes and standards:

1. EIA/TIA-568C: Commercial building telecommunications wiring standard and all current addenda
2. EIA/TIA-569A: Commercial building standard for telecommunications pathways and spaces
3. ANSI/TIA/EIA-606A: Administration standard for telecommunications infrastructure of commercial buildings
4. ANSI-J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications EIA/TIA-607: Commercial building grounding and bonding requirements for telecommunications
5. California Building Code (CBC)
6. California Electrical Code (CEC)
7. National and State Occupational Safety and Health Administration (OSHA) requirements.
8. National Fire Protection Association (NFPA), NFPA-70
9. Institute of Electrical and Electronic Engineers (IEEE) 802.3 (Ethernet), 802.3u (100 Base-TX/FX), 802.3z (Gigabit Ethernet over optical fiber), 802.3ab (Gigabit Ethernet over 4 pair category 5 or higher), 802.3ae (10GbE), 802.3be (40 and 100GbE), 802.3ad Link Aggregation Control Protocol, 802.11 (Wireless LAN) including 802.11ac (part 11 amendment 5), 802.11af (PoE), 802.11at (PoE+), 802.1d (spanning tree protocol), 802.1s (Multiple Spanning Tree Protocol), 802.1w (Rapid Spanning Tree Protocol), 802.1p (QoS), 802.1q (VLAN tagging), 802.1x (Port Based Network Access Control), RFC 2236/5186 (IGMP v2/v3), RFC 3973/4602 (PIM-DM/SM), RFC 2365 (Administratively Scoped IP Multicast)
10. ANSI, ASTM, UL, NEMA, IEEE and FCC standards as applicable.
11. ADA- Americans with Disabilities Act
12. BICSI Telecommunications Distribution Methods Manual, current edition
13. BICSI Wireless Design Reference Manual, current edition

#### 1.04 SUBMITTALS

- A. List of Materials: Submit a complete list of proposed materials and products.
1. Furnish catalog cuts, technical data, and descriptive literature on components. Data shall be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data. All UPS submittals shall be accompanied by a manufacturers run time matrix indicating capacity as required in this specification.
  2. Shop Drawings shall indicate equipment locations, details, sizes, and a point-to-point interface connection diagram of all systems. Shop Drawings shall indicate interfaces to cabling and equipment and cabling furnished by

others, identifying numbers of wires, termination requirements, and other pertinent details.

3. Drawings that are specific to this specification section shall be included in the submittal. "A" size (8.5"x11") and "B" size (11"x17") shall be bound into the manual. Larger drawings shall be folded and inserted into transparent envelopes that are bound into the manual.
4. Each submittal shall be bound and shall contain an index organized vertically by assembly and item number and horizontally by columns. The first assembly shall be the major head end equipment. The leftmost column shall be the item number; next shall be the description, followed by the applicable specification section number, and followed by the specified item, which is followed by the submitted item. The rightmost column shall be for notes, which shall be used to reference the reason for submitting items other than as specified. This is visually presented below. Column widths should be adjusted for easy reference and use of space.

Item Number	Description	Applicable Specification Section Number	Specified Item	Submitted Item	Notes:

- B. The product data shall be sufficiently detailed to allow the engineer to evaluate the suitability of the product and to allow other trades to provide necessary coordination.
- C. Provide a Design Review Summary of no more than two (2) pages. Summarize as appropriate, the design principles, equipment sizing, and/or installation practices used to determine the most cost effective method to meet the OWNER's requirements.
- D. Provide a migration plan that details the CONTRACTOR's transition and integration strategy from the existing LAN systems and connectivity to the new LAN systems and connectivity. This plan should be prepared by the CONTRACTOR and approved by the ITD Project Management Office.
  1. The Network Migration Plan shall define how existing LAN systems shall remain in service during the installation and integration of the new LAN/WLAN and converged systems.
- E. Provide a material list of all CONTRACTOR-provided or connected systems specifying quantity, part/specification, and serial numbers on an office, classroom, LDF, IDF, MDF, and IP address and room-by-room basis. Use building insurance numbers followed by the architectural classroom number.
  1. Submit the following documentation:
    - a. Drawings of network connectivity, as-built, in one hard copy and one copy provided on USB flash drive in the latest version of

AutoCAD or Microsoft Visio format for Microsoft Windows. All information shall be clearly legible on all printed drawings.

- b. OWNER utilizes layers as a key tool in controlling visibility of drawing elements and to provide consistent information between drawings, yet provide control over what is seen on each sheet. LAN Systems shall be shown on a separate layer, labeled as "LAN Systems" that uses building floor plans, conduit supporting structure, and premise wiring layers below as needed. The use of any version control blocks or company logos shall be on a layer separate from the LAN Systems drawings. Diagrams should include, at a minimum:
  - (1) All network connected systems provided by or installed by the CONTRACTOR including device type, model, serial number, OWNER assigned name, date installed, and OWNER provided IP Address. Device symbols should be industry standard symbols or replica of manufacturer's equipment. Drawings shall be laid-out to clearly show the logical relationship between devices.
  - (2) All SNMP managed devices connected to the network including device type, model, OWNER assigned name, and OWNER provided IP address.
  - (3) Location of equipment. Location is designated by:
    - (a) Building number as indexed on record drawings
    - (b) Room or location number as indexed on record drawings
    - (c) Distribution Frame number as indexed on record drawings
  - (4) Connections between installed systems including type of connection, interface speed, system interface ID, and cable number used.
  - (5) Rack/cabinet elevations indicating equipment locations. Equipment locations and placement within cabinets shall be approved by the ITI Project Management Office prior to equipment installation. CONTRACTOR and ITI Project Management Office shall agree as to the final location of all devices.
- c. Inventory of installed systems shall be documented in the OWNER Asset Management Excel Workbook as required by Contract Documents.

## 1.05 SUBSTITUTIONS

- A. Equipment and materials that deviate from these requirements shall not be accepted without written approval from OWNER'S Information Technology project manager. When deviating or proposing material substitutions the following information shall be submitted:
  - 1. Substitution request form substantiating reasons and benefits to OWNER, and all necessary documents to validate the claims made in the substitution form.
  - 2. Submittals must comply with contract general provisions.

#### 1.06 QUALITY ASSURANCE

- A. Work shall conform to CCR, Part 3, California Electrical Code.
- B. Only a qualified CONTRACTOR holding licenses required by legally constituted authorities having jurisdiction over the work shall do work.
  - 1. Provide the supervision necessary to install, and configure a complete and operational system.
    - a. Supervisor shall have demonstrated experience in the successful completion of at least three (3) projects of similar size and scope on-time and on-budget.
    - b. Supervisor shall have demonstrated the ability to supervise a telecommunications project of similar size and complexity.
- C. Provide and obtain approval from ITD for the installation plan, Installation shall conform with ITD approved installation practices.
- D. Test installation to validate functionality and interoperability with the OWNER WAN and converged systems.
- E. CONTRACTOR shall be an authorized distributor of the submitted LAN equipment and shall have one or more engineers and/or technicians who have been trained by the manufacturer (or manufacturer authorized organization) and certified in the design, installation, and configuration of the equipment.
- F. Submit a copy of a letter from the manufacturer of submitted equipment certifying that the installer is an authorized distributor and maintenance provider of the submitted manufacturer's equipment.
- G. CONTRACTOR shall include in the Material List Submission a list of five projects of similar scope acceptable to the OWNER and shall have a service organization capable of responding to warranty service requests within 24 hours of receipt of written notification and resolution within 1 day for MDF equipment and 3 days for equipment located either in the classroom, IDF, or LDF. CONTRACTOR shall include the telephone number of the customer's client contact for each project and a letter signed by a corporate officer, partner, or OWNER of the contracting company describing the service capability of the company and stating the company's commitment to maintain that service capability through the warranty period.

- H. The CONTRACTOR shall use adequate numbers of skilled staff who are manufacturer certified, thoroughly trained and experienced on the necessary technology and systems, and completely familiar with the specified requirements and methods needed for the proper performance of the work.

#### 1.07 WARRANTY

- A. CONTRACTOR shall warranty that all work executed and materials furnished shall be free from defects in materials and workmanship for a minimum period of five (5) years from date of installation acceptance, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. In the event a manufacturer's warranty is longer than five (5) years, the manufacturer's warranty shall be the warranty period. Immediately upon receipt of written notice from the OWNER, the CONTRACTOR shall repair or replace at no expense to the OWNER, any defective material or work that may be discovered before final acceptance of work or within the warranty period; any material or work damaged thereby; and adjacent material or work that may be displaced in repair or replacement. Examination of, or failure to, examine work by the OWNER shall not relieve CONTRACTOR from these obligations.
- B. All warranty shall provide the OWNER direct access to manufacturer Technical Assistance Center (TAC), software updates, and defect support.
- C. Manufacturer of provided equipment shall guarantee availability of parts common to provided system and/or full replacement units, for a period not less than 5 years. Parts for the supplied systems shall be available within 30 calendar days during the 5 year period.
- D. Installation CONTRACTOR shall install all equipment in accordance with manufacturer's specifications and recommendations necessary to ensure continuation of the manufacturer's warranty. If the installation CONTRACTOR cannot install manufacturer's equipment in such a manner, it is the responsibility of the installation CONTRACTOR to provide written, timely notification to OWNER ITD Project Management.
- E. OWNER monitors equipment service records and failure rates. In the event that the OWNER determines that a LAN system component, or model part, provided through this specification exceeds acceptable failure rate, or repeated failure rate, the CONTRACTOR shall replace all systems of the same model purchased through this procurement with a new model that meets or exceeds the same functional requirements. Units or components exceeding either the acceptable or repeated failure rates shall be known as a "mass failure." The CONTRACTOR shall provide qualified technicians to install the replacement systems and a project manager to coordinate replacement schedule with ITD. Replacement of mass failing systems, labor, and project management shall be provided and completed in accordance with this specification and related OWNER installation guidelines at no additional cost to the OWNER.
1. The acceptable failure rate/repeat failure rate for a single system model or individual modular model part, at a single site, or OWNER-wide, shall be:

- a. Equal to or less than 10% in any 12 month period during the original warranty term.
- b. Equal to or less than 15% cumulative failures during the entire term of the original warranty.
- 2. If, at any time during of the warranty term, the failure rate of the LAN systems or components exceeds 10%, the CONTRACTOR shall extend the original warranty term by one year, at no additional cost to the OWNER.
- 3. The CONTRACTOR is responsible for replacement of any failed equipment provided by the CONTRACTOR, during the warranty period or the extended warranty period. This includes equipment that falls under the “mass failure” definition.
- 4. In the event of a “mass failure” the CONTRACTOR shall replace all units and/or components affected within 60 days or written notification from the OWNER.
- 5. Upon replacement of each unit or component, the replaced unit warranty shall continue as if the original equipment were still in service.
- F. The warranty shall cover the complete system including fan assembly, power supplies, and the device itself.
- G. The warranty shall include onsite 48-hour advanced part replacement.
- H. The warranty shall include all labor to service and/or replace warranted system(s).
- I. In the event any Supplier or manufacturer offers additional warranty, at no additional cost, beyond that specified herein, CONTRACTOR shall state the terms of such warranty or warranties in writing and shall extend the same to the OWNER without additional cost.
- J. Equipment manufacturers shall have E-mail trouble reporting and response mechanisms in place and a toll free 24-hour help center to assist with troubleshooting and operation of the equipment at no additional cost to the OWNER, or as part of the warranty.

## PART 2 - PRODUCTS

### 2.01 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. CONTRACTOR shall Provide all labor, equipment, materials, parts and ancillary components that may be required in addition to the OWNER furnished systems.
- 1. The BBS is the Backbone Switch and is installed in the MDF and serves as the central point of backbone network termination, and provides network connectivity to IDFs, classrooms, computer labs, libraries, multi-purpose rooms, student nutritional service areas, auditoriums, and offices. The BBS shall provide the primary campus LAN routing/switching functions between user VLANs and the WAN router.

2. For instructional campus sites greater than 10 classrooms and office locations larger than 100 users, provide the minimum capability of a chassis-based modular switch with modular interface cards in the MDF as a Backbone Switch (BBS).
3. The ISM is the Intermediate Switch–Managed (Fiber Switch) serving as the network termination point for secondary fiber backbone cabling from an IDF to CESMs located in LDCs. The ISM aggregates CESMs to the BBS.
4. The ESM is the Edge Switch–Managed serving as the network termination point for copper horizontal cabling from an MDF, IDF or LDF to the work area outlet.
5. The CESM is the Compact Edge Switch-Managed and is a small form factor network access point serving as the network termination point for copper horizontal cabling from an LDC to the work area outlet.
6. The Access Router provides all IP protocol gateway services between the OWNER WAN and LANs at the local site. The Access Router shall be installed in the same MDF as the BBS. The Access Router may be used to provide native DHCP and NTP services for all devices at the local site. The typical Access Router shall connect to the OWAN via scalable Metropolitan Area Network or T1 (or multiple T1s). Circuits shall be provisioned by the OWNER and service type shall be identified on the Contract Documents.
7. An MDF is the structure that serves as the main cross-connect for backbone cabling and connectivity serving all campus LAN systems. The router and BBS shall be installed in the MDF. The MDF may also serve as an IDF for locations within 90 meters (copper cable length). Patch cables shall be practical in length such that they may be neatly loomed in the cable management system with minimal excess cable and no cable stress points.
8. The IDF provides the network connection point for secondary fiber backbone and /or horizontal copper cabling. The IDF may also provide cross-connect to backbone cabling where CESM are used. IDFs are located between the MDF, LDFs, and LDCs in classrooms, offices, and other end station locations.
9. The LDF is similar to an IDF but provides the network access point for a single room or adjacent rooms. An LDF typically uses a cabinet that serves as the termination point for horizontal copper UTP cabling within the same room and installation site of an ESM.
10. The LDC provides local network access for a single classroom single room. An LDC uses a wall-mounted (recessed or surface mount) cabinet that serves as the termination point for horizontal copper UTP cabling within the same room and installation site of a CESM (as required) within the room/area.

- B. CONTRACTOR shall provide LAN system equipment hardware, firmware, and software necessary in the MDF, IDF, LDF and classroom locations to provide PoE+ full duplex 10/100/1000 Base-T Ethernet ports to connect each workstation, server, router, and other end devices designated on the project document.
- C. The LAN system design and equipment shall provide, at a minimum, fiber based 10GbE backbone (uplink) connectivity from ISM and ESM equipment in IDFs, LDFs; ISM and CESM 1 Gigabit Ethernet fiber base to the BBS located in the MDF as specified in the project document.
- D. CONTRACTOR shall install, configure, test, and document the LAN equipment in accordance with Part 3 of this specification to provide a fully functional and complete LAN at each location identified in the Contract Documents. Installation shall include all cable patches at end-devices as well as cable patches in all MDFs, IDFs, LDFs, and classrooms to complete device connectivity to the OWNER WAN.
- E. CONTRACTOR shall coordinate patch cable runs, rack elevations/equipment locations, electrical power pathways, and available electrical capacity with the ITI Project Management Office prior to installation of the LAN systems. CONTRACTOR and the ITI Project Management Office must agree as to the final location/placement of all devices.
- F. CONTRACTOR shall coordinate patch cable runs, equipment locations, and electrical power requirements with the ITI Project Management Office prior to installation of the LAN systems. CONTRACTOR and the ITI Project Management Office must agree as to the final location and placement of all devices.
- G. CONTRACTOR shall test and document all installed systems in accordance with requirements and procedures stated in this specification.
- H. Provide an Uninterruptible Power Supply (UPS) system in the MDF. The UPS shall be sized according to section 2.03.G.

## 2.02 EQUIPMENT STANDARDS

- A. Proposed products must have been commercially available to the general public for a period of at least six (6) months and must be available for purchase at the time of bid submittal. No pioneering, unproven or experimental technologies/products are acceptable.
- B. In order to establish service stability, all proposed switching equipment e.g. BBS, ISM, ESM and CESM and components exclusive of routers and cabling shall be of like products from a single manufacturer for each site except otherwise approved by the OWNER.
  - 1. In order to establish a standard of quality as required by the OWNER, various manufacturers' equipment may meet the requirements in this document. As a reference for comparison of CONTRACTORS, the equipment specification sheets on all items shall be included with the submitted bid and design.

2. The Los Angeles Unified School OWNER's Information Technology Division or designated agent shall establish equivalency and compliance of product or components offered for use on each project.
3. Equipment support of Centralized Management.
  - a. The Los Angeles Unified School OWNER (LAUSD) requires that all networking components deployed on its OWNER-wide Network provide standard support for remote management from its central facility. For the purposes of this document, a network component is defined as any component or device that provides connectivity to the OWNER-wide Network. Examples include, but are not limited to, the following: Routers, Switches, Wireless Access Points and Uninterruptible Power Supplies.
  - b. CONTRACTORs proposing equipment for deployment on the OWNER Network shall ensure that each device as provided meets the following requirements:
    - (1) Each component shall support remote management in compliance with the Simple Network Management Protocol standards with community string authentication.
    - (2) Device operational status, name, descriptive information, and Operating System (OS) and/or firmware versions (e.g., MIB-II System tree).
    - (3) Interface operational status and traffic/error statistics for all interfaces in use (e.g. MIB-II Interfaces tree).
  - c. For the manufacturer equipment, the CONTRACTOR shall also include and enable for use all manufacturer developed SNMP agents and agent features available for the equipment. The only allowable exception to this requirement is that CONTRACTORs may choose not to include additional-cost agent features that pertain solely to device functions for which the device is not provided.
  - d. For devices with agents supporting private enterprise MIB extensions (ASN.1 Object Identifier .1.3.6.1.4.x) all extensions must be included and enabled for use. Additionally, when requested, the CONTRACTOR shall provide:
    - (1) Electronic documentation for all private enterprise MIB extensions supported by the device in Abstract Syntax Notation number One (ASN.1)/Structure of Management Information (SMI) MIB format.
    - (2) Electronic versions of SNMP manageable equipment shall include accessible Internet links (e.g., URL) to all manufacturer developed documentation regarding the features, use, and/or configuration of the device agent(s).

- e. If procedures for remote management, configuration, or software/firmware upgrades of the equipment require the use of proprietary or otherwise manufacturer-specific software, the CONTRACTOR shall include in submittal the specification (i.e. name, version, part number) and price for this software sufficient to perform remote management functions.

**C. Equipment Substitutions**

- 1. Equipment substitutions shall be pre-approved by the OWNER prior to bid date. CONTRACTOR shall demonstrate operation of equipment and compliance with functions and features specified herein. Additionally, CONTRACTOR shall demonstrate interoperability of design and systems with existing systems. Equipment substitutions that were not pre-approved prior to bid date shall be rejected. In the event that no equipment is found to meet all the requirements specified herein, the equipment meeting the most requirements shall be given preferential treatment during the selection process.

**D. Non-Proprietary Implementation**

- 1. This design and implementation specification precludes the use of any network equipment CONTRACTOR proprietary protocols or capabilities required to either deliver an operational overall system or preclude future implementations that rely on prevailing industry standards.

2.03

**LAN EQUIPMENT**

**A.** Access Router: The Access Router provides the interface between the local network (LAN) and the Wide Area Network (WAN). The router also provides critical IP services such as QoS, DHCP, and NTP. The router is required to provide a variety of interface capability to support individual site requirements. Many of the named interfaces and protocols may not be required during the initial implementation; however, the ability to implement any of the listed capabilities is required.

- 1. The general router requirements are as follows:
  - a. Modular configuration with slots supporting different interface module types.
  - b. Hot-swappable, load-sharing or redundant power supplies
  - c. Rack-mountable in standard 19-inch rack.
  - d. WAN interface(s) to meet requirements specified in the project record. See following sections for supported interfaces and “as provided” requirement.
  - e. Up to eight T1 synchronous serial ports with built-in DSU/CSU capabilities - to be specified in the Contract Documents.
  - f. Software and firmware to support the OWNER MAN/WAN requirements.

02/28/1017

- g. Maximize use of internal memory to support the next two major operating system upgrades. External compact flash memory shall not be accepted.
2. The router shall be capable of supporting the following:
  - a. Minimum of four Gigabit Ethernet ports
  - b. 1000 Base-SX, LX, and ZX interfaces through SFP GBIC modules.
  - c. Minimum of one T1 Channelized Primary Rate ISDN (PRI).
  - d. Minimum of eight T1 synchronous serial ports supporting data 1.544Mbps with built-in Data Service Unit/Channel Service Unit (DSU/CSU).
  - e. Minimum of two FXO and two FXS interfaces for PSTN connection, telephone set, fax machine, PBX or PA/IC connection; or have the ability to support Session Initiation Protocol. The router must also be capable of providing Voice over IP PSTN fail-over in the event the WAN IP interface becomes temporarily inoperable.
  - f. Industry standard Voice over IP protocols including MGCP, H.323, and SIP.
  - g. SNMP, syslog, traffic analyzer data e.g. sFlow, Netflow, IPFIX
  - h. Hot-swappable, load-sharing or redundant power supplies.
  - i. Dual stack Internet Protocol IPv4 and IPv6
  - j. MPLS
  - k. VRF-Lite
  - l. GRE tunnels
  - m. BFD
  - n. WCCP v2
  - o. PPP Multi-link of serial interfaces
  - p. QoS with the ability to provision 802.1p priority queues and utilize basic dynamic application detection
  - q. The Access Router's performance, at the minimum, shall be no less than 1.5 Gbps throughput with any of NAT, ACL, HQoS, or IPsec features enabled utilizing RFC 2544 standard baseline testing method and IMIX packet sizes
3. The router, as provided, shall support the following:
  - a. Minimum of the following ports installed, unless otherwise specified by the OWNER:
    - (1) Three auto-negotiating 10/100/1000 Base-T Ethernet ports

- b. Minimum of the following IP routing protocols installed:
  - (1) BGP-4 and MP-BGP
  - (2) IGMP v2
  - (3) OSPF v2 and OSPF v3
  - (4) PIM (dense mode and sparse mode)
  - (5) RIP and RIP v2
  - (6) RIPng
- c. IP Multicast
- d. Network management via industry standard protocols including SNMP, remote configuration, remote notification of errors, events, and alerts.
- e. In-band configuration via command line interface over Telnet, SSH, and SNMP, and out-of-band configuration via direct serial, terminal server, or dial-up (modem) connection.
- f. Centralized user access control and configurable access levels.
- g. Support for access control-based security model. For example, access control lists.
- h. Logging to report user access, configuration changes, system events, traps, and other interface and protocol events, including support for a centralized syslog server.
- i. Internet Protocol IPv4 and IPv6, MPLS.
- j. The router shall provide native DHCP and NTP services for all devices at the local site.
- k. Network Time Protocol (client mode).
- l. IPSec with NAT, PAT, and NAT-PT
- m. The Access Router's performance, at the minimum, shall be no less than 1.5 Gbps throughput with any of NAT, ACL, HQoS, or IPSec features enabled utilizing RFC 2544 standard baseline testing method and IMIX packet sizes

#### B. Broadband Access Router

The Broadband Access Router provides the interface between the local network (LAN) and the commercial wireless cellular broadband network. The router is required to provide a variety of interface capability to support individual site requirements. Many of the named interfaces and protocols may not be required during the initial implementation; however, the ability to implement any of the listed capabilities is required.

1. The general Broadband Access Router requirements for non-WiFi are as follows:

- a. Support dual SIM for cellular 4G.
  - b. IPSec in compliance with IETF.
  - c. 10/100/1000 Ethernet interface.
2. The general Broadband Access Router requirements for WiFi are as follows:
    - a. Support dual SIM for cellular 4G.
    - b. IPSec in compliance with IETF.
    - c. 10/100/1000 Ethernet interface.
    - d. Wireless LAN access point in compliance with IEEE 802.11 a/b/g/n.
- C. Backbone Switch (BBS): The BBS shall be a modular, rack mountable, chassis based switch with a number of slots as required by the site network configuration. A single BBS shall be used for aggregating LAN system connections (uplinks) and local MDF connectivity for the complete site.
1. The general BBS requirements are as follows:
    - a. Hot swappable, load sharing power supplies (minimum of two installed).
    - b. The BBS shall support in-band configuration via command line interface over Telnet, SSH, or HTTP.
    - c. The BBS shall be of sufficient size to accommodate and of appropriate functional design to support the specified modules regardless of whether all of these modules are required to be furnished at time of installation.
    - d. The optic based Gigabit Ethernet Switch Modules with a minimum of twelve 1000 Base-SX/LX ports per module. The number of such modules configured in the BBS should be sufficient to provide the minimum of one 10 GbE port for each ISM and one 1 GbE port for each CESM uplink connection. SFP GBIC modules are not required for spare ports.
    - e. Fiber optic based 10GbE Switch Modules with a minimum capability of six SFP+ ports per module. The number of such modules configured in the BBS should be sufficient to provide one port for each ESM and one port for each ISM, unless specified otherwise by OWNER staff, configured with a SFP+ 10GbE multi-mode or single mode uplink connection as needed of each type. SFP+ modules are not required for spare ports. Fiber network interface modules shall be designed for multi-mode and/or single-mode fiber as appropriate for the required interface and distance.
    - f. The BBS shall support multiple link aggregation for 10GbE and/or 1GbE uplink connections to support higher bandwidth uplink

connections, as required by performance criteria. Aggregated uplink connections shall adhere to the IEEE 802.3ad, Link Aggregation Control Protocol specifications. The BBS shall be capable of supporting a minimum of 4 aggregated ports per uplink.

- g. The Installing CONTRACTOR shall supply multi-mode and single-mode duplex fiber patch cables, as appropriate, for every fiber interface provided. Patch cables shall be supplied to provide the required duplex interface to the fiber patch facility. Refer to section 3.01.E for general fiber patch cable requirements. Patch Cables shall be of sufficient length to reach maximum, worst-case length, neatly loomed in the wire management system from the switch to the fiber patch facility. For typical BBS site configurations, the minimum length shall be 1 meter and the maximum length shall be 5 meters.
  - h. Maximize use of internal memory to support the next two major operating system upgrades. External compact flash memory shall not be accepted.
  - i. The BBS performance shall provide at a minimum:
    - (1) For instructional sites with greater than 3,000 users; a minimum of layer 2 switching throughput of no less than 900 Gbps. Layer 3 IPv4 200 Mpps and IPv6 100 Mpps of throughput.
    - (2) For instructional sites with equal or less than 3,000 users; a minimum of layer 2 switching throughput of no less than 768 Gbps. Layer 3 IPv4 200 Mpps and IPv6 100 Mpps of throughput
    - (3) For instructional sites with less than 100 users; a minimum of layer 2 switching throughput of no less than 80 Gbps. Layer 3 forwarding rate no less than 60 million packet per second (Mpps)
2. The BBS shall be capable of supporting the following:
- a. Sufficient redundancy so that despite the failure of any single replaceable processor, management, or switching fabric component (excluding end-device port modules), the BBS shall maintain its configuration information, the ability to enforce Virtual LANs (VLANs), filtering/forwarding policies, perform routing, and to support network management functions. This redundancy does not apply to end device ports or fiber trunks to ISMs, ESMs, or CESMs unless otherwise specified in the procurement document.
  - b. Modules which are compatible with specified uplink modules of corresponding data rates and media types for the provided ESM Switches.

- c. In order to support future increased efforts to deploy multimedia presentations to the classroom, the Backbone Switch shall be capable of interoperating with other equipment manufacturer routers operating in a standards-based IP environment.
  - d. Modules that provide Industry standard 802.3at or PoE+, power over Ethernet, without the requirement for an external power injector.
  - e. All BBS network modules port-to-backplane throughput shall not exceed;
    - (1) 2-to-1 over subscription on 1G line cards.
    - (2) 3-to-1 over subscription on 10G line cards.
  - f. Network Time Protocol (client mode).
  - g. DHCP snooping or protection
  - h. Uni-Directional Link Detection (UDLD)
  - i. 802.1x compliant with support for multiple policies per port.
  - j. Energy conservation features such as the ability to reduce power consumption at times of little activity.
  - k. Support the following routing protocols: OSPFv2, OSPFv3, IGMP V2, PIM, RIP, RIPv2, and RIPng.
  - l. The BBS shall provide QoS services at the local site.
  - m. IEEE 802.1s Multiple Spanning Trees – The BBS shall be capable of supporting multiple, independent Spanning Tree Domains supporting multiple VLANs per domain. Each Spanning Tree Domain must be able to establish its own root bridge and active path.
3. The BBS, as provided, shall support (or provide) the following:
- a. Full compliant with the IEEE 802.3ae, 10GbE; unless otherwise noted by OWNER project requirement.
  - b. Network management via industry standard protocols including SNMP, remote configuration, and remote notification of errors, events, and alerts.
  - c. Static IP address assignment for the network management interface.
  - d. Logging to report user access, configuration changes, system events, traps, and other interface and protocol events.
  - e. Supporting network modules for specified uplink of corresponding data rates and media types for the provided ISM, ESM, and CESM Switches.
  - f. Minimum of one 24-port PoE+ 10/100/1000 Base-T Ethernet

module. The total number of PoE+ 10/100/1000 Base-T Ethernet ports required in the BBS must be determined on a site-by-site basis based on the Contract Documents for each site. All software features, firmware, and protocol support identified for the BBS in this specification.

- g. Minimum of one empty module slot with a blank cover for future expansion.
- h. Interoperate with the same user-created VLANs as on all switches to include the capability for VLANs to span across multiple switches connected to different ports on the BBS. Further, the Backbone Switch shall support a minimum of 1024 VLANs and shall fully support IEEE 802.1q frame tagging functions with native VLAN un-tagged capability.
- i. Transport and delivery of industry standard IP Multicast. The BBS shall, at a minimum, support IGMP V2 and IGMP snooping.
- j. IEEE 802.1p quality of service functions. QoS support must honor priority set by end devices to support Voice over IP and Video connections as well as support per port priority settings.
- k. User configurable to forwarding and filtering decisions based on protocols and applications to include Transmission Control Protocol (TCP) application ports and/or source/destination IP address filtering. The forwarding and filtering decision abilities shall be capable of enforcing policies on communications between different subnets or VLANs within the campus network as well as on communications through the OWAN connection or the Internet.
- l. IEEE 802.1s Multiple Spanning Trees – The BBS shall be capable of supporting multiple, independent Spanning Tree Domains supporting multiple VLANs per domain. Each Spanning Tree Domain must be able to establish its own root bridge and active path.
- m. Dual power supplies configuration.

**D. Intermediate Switch-Managed (ISM):**

1. The ISM shall be a 19-inch rack mountable gigabit fiber switch:
  - a. Full compliant with the IEEE 802.3ae, 10GbE for uplink connection unless otherwise noted by OWNER project requirement.
  - b. The ISM Switches shall provide a minimum of twelve fiber-based 1 Gigabit Ethernet ports each and shall provide a modular slot to accommodate a variety of uplink modules. The available Uplink module options shall include, at a minimum:
    - (1) 1GbE, or;

- (2) 10 GbE SFP+
  - c. Fiber interface modules shall be designed for multi-mode and/or single-mode fiber as appropriate for the required interface and distance.
  - d. There are no empty port expansion requirements for an ISM. ISM provision one 10 GbE uplink to the BBS. When applicable, aggregated uplink connections shall adhere to the IEEE 802.3ad Link Aggregation Control Protocol specifications.
  - e. The ISM switches' performance shall provide at a minimum:
    - (1) Provide at a minimum wire-speed, fully non-blocking performance within the switch.
    - (2) Provide a worst-case switch throughput of no less than 3 Gbps.
    - (3) Provide no less than 3 million 64-byte packets per second throughput Layer 2 with any or all features enabled.
  - f. Network Time Protocol (client mode).
2. The ISM shall be capable of supporting the following:
- a. DHCP snooping or protection.
  - b. Uni-Directional Link Detection (UDLD) or equivalent
  - c. 802.1x compliant.
  - d. Energy conservation features such as the ability to reduce power consumption at times of little activity.
3. The ISM, when provided as a Small-Site Backbone Switch (small BBS), shall support (or provide) the following:
- a. Full compliant with the IEEE 802.3ae, 10GbE uplink; unless otherwise noted by OWNER project requirement.
  - b. Network management via industry standard protocols including SNMP, remote configuration, remote notification of errors, events, and alerts.
  - c. Static IP address assignment for network management.
  - d. In-band configuration via command line interface over Telnet, SSH, or HTTP.
  - e. Remote configuration load via TFTP or FTP.
  - f. Logging to report user access, configuration changes, system events, traps, and other interface and protocol events.
  - g. 1GbE uplink module as appropriate for distance connection to CESMs.

- h. The switch shall support a minimum of 255 VLANs and shall fully support IEEE 802.1q frame tagging functions with native VLAN un-tagged capability.
  - i. At least one fiber optic port for 1000 Base-SX as required for CESM. The use of media conversion external to the switch is not permitted by the OWNER.
  - j. IEEE 802.1p quality of service functions. QoS support must honor priority set by end devices to support Voice over IP and Video connections as well as support per port priority settings.
  - k. Transport and delivery of industry standard IP Multicast.
  - l. DHCP snooping or protection.
  - m. Uni-Directional Link Detection (UDLD) or equivalent
  - n. 802.1x compliant with support for multiple policies per port.
  - o. Energy conservation features such as the ability to reduce power consumption at times of little activity.
4. The ISM with a single power supply acoustic noise level shall not exceed 46 dB.
- E. Edge Switch-Managed (ESM): The ESM shall be a modular or workgroup, 19-inch rack mountable switch, and manageable via a single IP address.
1. The general ESM requirements are as follows:
    - a. Full compliant with the IEEE 802.3ae, 10GbE uplink; unless otherwise noted by OWNER project requirement.
    - b. The ESM Switches shall provide a minimum of twenty-four auto-negotiating 10/100/1000 Base-T with atleast one-half of total ports shall be equipped with PoE+. Each and shall provide a modular slot to accommodate a variety of uplink modules. The available uplink module options shall include, at a minimum, 10GbE multimode or single mode SFP+ modules; or 1GbE multimode or single mode uplink module option.
    - c. Fiber interface modules shall be designed for multi-mode and/or single-mode fiber as appropriate for the required interface and distance.
    - d. The ESM switches' performance shall provide at a minimum:
      - (1) Provide at a minimum wire-speed, fully non-blocking performance within the switch.
      - (2) Provide a worst-case switch throughput of no less than 80 Gbps.
      - (3) Provide no less than 32 million packets per second throughput Layer 2 with any or all features enabled.

- e. Network Time Protocol (client mode)..
2. The ESM shall be capable of supporting the following:
  - a. DHCP snooping or protection
  - b. 802.1x compliant with support for multiple policies per port.
  - c. Energy conservation features such as the ability to reduce power consumption at times of little activity.
3. The ESM shall meet the following:
  - a. Full compliant with the IEEE 802.3ae, 10GbE uplink; unless otherwise noted by OWNER project requirement.
  - b. Network management via industry standard protocols including SNMP, remote configuration, remote notification of errors, events, and alerts.
  - c. Static IP address assignment for network management.
  - d. In-band configuration via command line interface over Telnet, SSH, or HTTP/HTTPS.
  - e. Remote configuration load via TFTP or FTP.
  - f. Logging to report user access, configuration changes, system events, traps, and other interface and protocol events.
  - g. 10GbE SFP+ multimode or single mode module as appropriate for distance for each connection to the BBS, unless otherwise noted by the OWNER's project instruction.
  - h. Interface to the BBS Switch and interoperate with the same user-created VLANs as on the ESM Switches to include the capability for VLANs to span across multiple ESMs connected to different ports on the BBS or ISM. The switch shall support a minimum of 255 VLANs and shall fully support IEEE 802.1q frame tagging functions with native VLAN un-tagged capability.
  - i. At least one fiber optic port for 10GbE SFP+ multimode or single mode as required, plus PoE+ 10/100/1000 Base-T ports sufficient to accommodate active horizontal UTP connections.
  - j. IEEE 802.1p quality of service functions. QoS support must honor priority set by end devices to support Voice over IP and Video connections as well as support per port priority settings.
  - k. Transport and deliver of industry standard IP Multipcast. The ISM and ESM shall, at a minimum, support IGMP V2 and IGMP snooping.
4. The ESM with a single power supply acoustic noise level shall not exceed 46 dB. Project proposal must include manufacturer published product

datasheets, which shall include acoustic noise information for technical evaluation purposes.

F. Compact Edge Switch-Managed (CESM)

1. The general CESM requirements are as follows:
  - a. The CESM shall be 19-inch rack mountable and shall not exceed 1 Rack Unit (1.75") mounting height and shall not exceed 14 inches mounting depth.
  - b. The CESM shall be of a type that operates silently and does not require a fan (internal or external) for cooling.
  - c. The CESM Switch shall provide at a minimum wire-speed, fully non-blocking performance within the switch.
  - d. Capable of supporting SNMP
  - e. DHCP snooping or protection
  - f. 802.1x compliant.
  - g. Energy conservation features such as the ability to reduce power consumption at times of little activity.
2. The CESM shall meet the following:
  - a. Minimum of seven, but not to exceed twelve, auto-negotiating PoE 10/100/1000 Base-T ports.
  - b. Minimum of one user selectable uplink port capable of supporting 1000 Base-SX, or 1000 Base-LX, designed for use with multi-mode or single mode fiber for connectivity to the corresponding interface in the BBS or ISM switch.
  - c. Fiber interface modules shall be designed for multi-mode or single-mode fiber as appropriate for individual required interfaces, distance, and connectivity to the corresponding modules in the BBS, or ISM Switch.
  - d. Interface with the ISM and BBS switches and interoperate with the same user-created VLANs as on the ISM and BBS switches. Further, the CESM shall fully support IEEE 802.1q frame tagging functions with native VLAN un-tagged capability.
  - e. IEEE 802.1p quality of service functions. QoS support must honor priority set by end devices to support Voice over IP and Video connections as well as support per port priority settings.
  - f. Transport and delivery of industry standard IP Multicast. The CESM shall, at a minimum, support IGMP V2 and IGMP snooping.

- g. Network management via industry standard protocols including SNMP, remote configuration, and remote notification of errors, events, and alerts.
  - h. Static IP address assignment for the network management interface.
  - i. In-band configuration via command line interface over console Telnet, SSH, or HTTP.
  - j. Remote configuration load/upgrade via TFTP or FTP.
- G. Uninterruptible Power Supply (UPS): UPS is required for all LAN system equipment in the MDF.
1. The general UPS requirements are as follows:
    - a. Each UPS shall provide network grade line conditioning, lightning protection, surge protection, and protection against voltage swell and sag.
    - b. The UPS shall continue to conduct electricity regardless of the battery condition or state.
    - c. The UPS shall receive one auto-negotiate Ethernet Interface supporting SNMP.
    - d. The UPS systems shall support user replaceable, valve regulated lead acid, batteries. The UPS shall support a bypass mode or otherwise support battery service and replacement without interrupting power to the equipment plugged into the UPS.
  2. The UPS shall meet the following:
    - a. Ethernet Interface supporting SNMP.
    - b. Initiating a safe system shutdown by a server. All necessary hardware and software shall be included.
    - c. The UPS shall provide, after a loss of AC power input, the capability to support the continued operation of the connected equipment provided as part of this specification as follows:
      - (1) MDF– 60 minutes run time.
      - (2) IDF/ LDF- UPS not required for non-convergence sites.
    - d. On sites where IP convergence technology is being employed, all UPS' shall have 60 minutes run time regardless of the type of frame that it is installed in:
      - (1) MDF – 60 minutes run time
      - (2) IDF/ LDF – 60 minutes run time

**PART 3 - EXECUTION****3.01 GENERAL**

- A. To ensure that the installation does not diminish the existing capabilities of any school and as precursor to the execution and installation of any LAN equipment, the CONTRACTOR shall review the migration plan for each school with the OWNER's Program Office before a NTP at the school is provided.

**3.02 LAN INSTALLATION**

- A. CONTRACTORS implementing network components on the OWNER Network are responsible for the initial configuration of the component in compliance with the following OWNER standards:

1. The device shall be physically connected into the OWNER's network using OWNER-approved cabling, cabling specifications, and into the connection point specified by OWNER staff.
2. The device shall be configured in a manner that allows its management functions to be successfully verified by central staff. At a minimum, this includes configuration of the management agent with OWNER-provided values for the following configuration items:
  - a. IP address of all network interfaces
  - b. IP address of the gateway
  - c. VLAN
  - d. Read-Only SNMP Community String
  - e. Read-Write SNMP Community String
  - f. Centralized authentication/access server.
  - g. IP-based SNMP access control
  - h. SNMP trap receiver (destination)
3. All LAN systems shall be installed in accordance with CONTRACTOR installation guidelines and in compliance with the product warranty.

**B. Routers**

1. The router shall provide the interface to connect the local network to the centralized OWAN Distribution point(s). A minimum of three physical LAN interfaces shall be required. A minimum of one OWAN interface shall be required. Refer to the Contract Documentation for specific site requirements.
2. The router shall provide the single point of OWAN connection from the BBS for the entire LAN. A minimum of one OWAN interface shall be required. Refer to the Contract Documentation for site specific requirements.

3. The router shall be installed in the MDF for the site in the cabinets provided and designated for such.
4. The router shall be installed in accordance with CONTRACTOR installation guidelines and in compliance with the product warranty.

C. Backbone Switch (BBS)

1. Unless otherwise specified in Contract Documentation, there shall be one BBS per location installed in the MDF.
2. The BBS shall be mounted in the designated cabinet, usually the same cabinet or adjacent cabinet to the fiber patch facility and UPS system.
3. The BBS is the central point to which all connections from IDFs and LDFs are terminated. It is also the point at which connection to the OWAN router is made along with connectivity to designated primary campus servers.
4. The Backbone Switch constitutes the intelligent electronics portion of the collapsed backbone ARCHITECTure upon which the system design is based. The BBS shall provide the primary routing functions between user VLANs, between the user VLANs and the Router, and between the user VLANs and the OWAN if an Access router is not to be installed at the site.
5. Installed in accordance with CONTRACTOR installation guidelines and in compliance with the product warranty.

D. Edge Switch–Managed (ESM)

1. ESM Switches (Copper Switches) are used, as required, to provide network connectivity to copper connections that are terminated in IDF and LDF cabinets. The ESM Switches are intended to be located in IDF or LDF cabinets and connect via fiber optic uplink(s) to the BBS. Where ESM switches are located in LDF cabinets fiber optic patch cables installed between secondary backbone and primary backbone fiber patch panels.
2. Each ESM shall be mounted within an IDF or LDF cabinet.
3. An ESM shall be used, when required, to provide connectivity in the following:
  - a. Library
  - b. Multi-purpose room(s)
  - c. Cafeteria
  - d. Gymnasium(s) and Auditorium as specified on the site plan
  - e. Computer Lab(s) as specified on the site plan
4. Installed in accordance with CONTRACTOR installation guidelines and in compliance with the product warranty.

**E. Fiber Patch Cables**

1. The CONTRACTOR shall supply multi-mode and single-mode duplex fiber patch cables, as appropriate, for every fiber interface provided. Patch cables shall be supplied to provide a duplex interface to the fiber patch facility.
2. Unless otherwise defined in the Contract Documents, Fiber Patch facilities shall use the following convention:
  - a. Structured cabling fiber patch facility terminations shall be consistent throughout the facility (LC).
  - b. Sites with 50 micron multi-mode fiber shall use LC patch facility terminations (single mode as well as multimode fiber).
3. All patch cables shall be new and shall be certified by the manufacturer for use on the designated equipment interface and the installed fiber cable plant.
4. Fiber patch cable length shall vary depending on location. All patch cables must be of sufficient length to be neatly loomed in the cable management system between the fiber patch facility and the designated equipment interface.
5. 50 micron multi-mode patch cables shall be aqua, and single mode patch cables shall be yellow.

**F. Uninterruptible Power Supply (UPS)**

1. Each MDF shall be installed with a UPS.
2. The CONTRACTOR shall coordinate the appropriate power connection for each UPS as specified by the UPS manufacturer's installation requirements and applicable local, state and federal electrical, fire and safety codes.
3. UPS shall be rack mounted at the bottom (or near the bottom) of the cabinet/rack or adjacent rack of the systems for which it shall provide power. If installed in a cabinet in a "raised floor" room, a minimum of 4 inches and maximum of 7 inches of open rack space shall be maintained at the bottom of the rack.
4. Access to the front and back of the UPS shall not be impeded. All service access doors and cages shall be fully accessible.
5. Neither the UPS or associated battery packs shall rest on the bottom of the cabinet, rack or the floor
6. Provision a SNMP interface card for all UPS. Connect and configure the UPS SNMP, Ethernet interface to the network using OWNER provided device name and IP address. Other configuration requirements are contained elsewhere in this specification.
7. Installed in accordance with CONTRACTOR installation guidelines and

in compliance with the product warranty.

**3.03 RELATED SYSTEMS OR SUB-COMPONENT INSTALLATION**

**A. Labeling and Marking**

1. Provide complete equipment and cable location charts and as-built documentation in an envelope and attach to the inside rear doors of distribution frame cabinets in wiring spaces.
2. Mark all patch cables with computer-generated labels. Patch cables shall be labeled with the same identifier as on the receptacle faceplate, and/or on the patch panel. Cable markers shall be located within 2 inches of each end of the cable jacket and shall be directly readable. The cable marker at both ends of the cable shall be identical and shall identify both the source (device/port) and destination (jack, patch panel, or device/port position identifier). A disk with the label files shall be submitted as part of the project record documents.

**3.04 CERTIFICATION AND TESTING**

**A.** All hardware components (e.g. switches, routers) shall be tested for proper installation (per manufacturers' recommendations) and configuration. All components shall be tested using standard TCP/IP application utilities that collectively address network layer connectivity, IP packet path routing, and network performance. These tests are to be conducted during normal operation and for each site individually. Test results shall be indexed by site and device tested. Provide one hardcopy (8 ½ x 11 format) and three electronic copies in Microsoft Excel (newest version for Windows) format. The Excel file shall contain columns for the site name, location, device name, interface, and results for each test.

1. Internet Control and Message Protocol (ICMP) Ping Test: This test verifies the network layer for connectivity by using Ether-type frame pings to reach IP target addresses and obtain or verify four results: 1) the target IP address, 2) the local media access control (MAC), 3) the number of responses, and 4) the response time. Each test shall be conducted from all areas to the router interface and from at least one connection per VLAN to at least one connection on all other VLANs, as required. Each test includes two steps, as necessary:
  - a. Obtain the four results by performing an address resolution protocol (ARP) for the target IP address and by verifying the ping.
  - b. If test 1 is unsuccessful, obtain the four results by executing an ARP for the default router, then use the acquired MAC address to determine the IP address, send an ICMP echo request, and monitor for the ICMP reply.
  - c. ICMP Test results shall identify the target device IP address and Pass/Fail result.

2. Trace Route/Path Discover: This test determines the path IP packets follow and reports each router encountered in the path. Testing elicits an ICMP TIME-EXCEEDED response from each router encountered. Each hop is tested three times to help identify changing routes. The delay between each of the three tests shall not be less than 15 seconds and not more than 1 minute. This test shall be conducted from a workstation on each VLAN with a destination address to be provided by the OWNER.
  - a. Trace Router/Path Discover test results shall be recorded as Pass – same route all three tests; or Fail – different route reported in one of the three tests. In the event of Fail, an explanation of why a different route was reported must be provided.
3. Configuration Test: This test verifies that each new network port is operational. Perform an ICMP ping from each port not previously tested ensuring each port has link light indicating port operability. Any failures in any one port shall constitute the return of the failed equipment for new network equipment from the appropriate CONTRACTOR. Test results should identify the VLAN, IP address obtained or assigned for each port, the target device IP address, and the Ping results (Pass/Fail).
4. Completion: CONTRACTOR's work for each school installation shall be considered complete after the following have been accomplished:
  - a. All system testing has been completed, CONTRACTOR certifies that entire system is in working order, and Test Forms and Project Record Documents have been submitted and approved by the OWNER.
  - b. All ceiling panels previously removed have been put back in place.
  - c. All system labels have been put in place.
  - d. All construction and installation debris and scrap materials have been removed from project site.
  - e. All marked up, project record documents have been returned to the OWNER.
  - f. All unused customer material has been returned to the OWNER.
  - g. The OWNER has successfully completed acceptance testing of the network installation.
  - h. The OWNER's Inspector has inspected and accepted the installation.
  - i. Documentation, to include AS-builts, along with required soft copies has been turned over to the OWNER.

### 3.05 PROJECT RECORD DOCUMENTS

- A. Prior to the submittal of any final documentation, the CONTRACTOR shall provide to the IT Infrastructure Project Management Office the following for the

entire contract:

1. Three (3) electronic copies on USB flash drive of the hardware manufacturer documentation (PDF format) and software per model number of equipment installed throughout the project.
- B. Prior to the submittal of final documentation for each site, the CONTRACTOR shall provide the following to the IT Infrastructure Project Management Office for review and acceptance:
1. One (1) 24" x 36" hard (paper) copy of the completed full set of As-Builts.
  2. One (1) electronic (USB flash drive) copy of the completed full set of As-Builts in latest AutoCAD or Microsoft Visio file format.
  3. Complete set of original red line drawings.
  4. One (1) hard (11" x 17" paper) copy and one electronic copy of the asset/inventory list utilizing the OWNER required Excel format
  5. One (1) hard (11" x 17" paper) copy and one electronic copy of the inventory list of equipment removed from the site utilizing the OWNER required Excel format.
  6. One (1) hard (8 ½" x 11" paper) copy of the final invoice (bill of materials) for all work, E-rate discounted and/or funded through other sources under the contract.
  7. One (1) hard (8 ½" x 11" paper) copy of the Visio diagram of the OWNER approved warranty process, the warranty term effective from T&A acceptance, and written narrative that outlines the details the process that includes but is not limited to the following:
    - a. CONTRACTOR's warranty contact information
    - b. CONTRACTOR's process for tracking changes during the warranty period.
  8. One (1) electronic (USB flash drive) copy of the complete set of final test results in native format and one hard (8 ½" x 11" paper) copy of the test result summary. Included on the electronic USB flash drive copy shall be the associated software to read the test results.
  9. One (1) hard (8 ½" x 11" paper) copy of the cable management plan (in Excel format) as required in Specification 25569.
  10. One (1) hard (8 ½" x 11" paper) copy of all site specific signed RFCs, one (1) hard (8 ½" x 11" paper) copy of the General RFC log, and one (1) electronic USB flash drive copy of all RFCs for the site.
- C. Once the above referenced documents have been accepted, the CONTRACTOR shall provide to the IT Infrastructure Project Management Office the following for each site:
1. Three (3) electronic closeout USB flash drive copies. Disk label shall include project name, school name, school location code, contents

descriptor, table of contents, revision number and date of disk, and CONTRACTOR information. Each electronic closeout USB flash drive shall contain the following:

- a. Submit media in paper sleeve with see thru window.
- b. A cover page with school name, location code, address, project name, prepared for, prepared by, revision number, and the final revision date of the bound book
- c. A table of contents
- d. The asset/inventory list utilizing the OWNER required Excel format
- e. The final invoice (bill of materials list as required for closeout documentation) for all work, E-rate discounted and/or funded through other sources under the contract
- f. The complete set of final cable test results in native format and the associated software to read the test results
- g. The cable test result summary in PDF format
- h. The cable management plan A Visio diagram of the OWNER approved warranty process, the warranty term effective from T&A acceptance, and written narrative that outlines the details the process that includes but is not limited to the following:
  - i. CONTRACTOR's warranty contact information
  - j. CONTRACTOR's process for tracking changes during the warranty period following OWNER requirements outlined in the RFP.
  - k. The accepted full set of As-Builts with required BICSI/PE stamps and signatures
  - l. All site specific RFCs and the General RFC log
  - m. All General RFCs for the project
2. Four (4) electronic USB flash drive copies of the completed full set of As-builts in latest AutoCAD or Microsoft Visio file format.
3. Two (2) electronic USB flash drive copies, identified with "IT Asset Management", which shall consist of the following:
  - a. The asset/inventory list utilizing the OWNER required format.
  - b. The inventory list of equipment removed from the site utilizing the OWNER required format.
  - c. A Visio diagram of the OWNER approved warranty process, the warranty term effective from T&A acceptance, and written narrative that outlines the details the process that includes but is not limited to the following:

- 1) CONTRACTOR's warranty contact information
  - 2) CONTRACTOR's process for tracking changes during the warranty period
  - 4. All MDF, IDF, and LDF cabinet keys; No keys are to be left with the schools.
  - 5. Unattached accessories for all electronic equipment at the school site (including serial and other cables, adapters, etc.). The OWNER shall identify the quantities required.
  - 6. The CONTRACTOR shall provide to the IT Infrastructure Project Management Office and identified as "Facilities Vault" for each site, one (1) electronic USB flash drive copy of accepted As-Builts in latest AutoCAD or Microsoft Visio file format.
  - 7. One (1) 24" x 36" hard (paper) copy of the completed full set of As-Builts.
- 3.06 PROTECTION
- A. Protect the Work of this section until Substantial Completion.
- 3.07 CLEANUP
- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.
- 3.08 OWNER ORIENTATION (TRAINING)
- A. Before contract closeout of installation, provide to designated OWNER personnel:
    - 1. Provide a minimum a one week training course for OWNER designated representatives. The content of the training is advanced instruction on the use, programming, maintenance and troubleshooting of the LAN/WAN devices associated within this specification. Materials shall include training manuals and hands-on lab exercises. The training shall be delivered during the funding year. The training shall be provided at the equipment manufacturer's authorized training facility located in Los Angeles County. Training shall consist of classroom instruction including intensive course work covering the following topics:
      - a. Product Features and Technical Specifications
      - b. Implementation and Design as-built including installed LAN/WAN ARCHITECTure, familiarization with drawing sets, symbols and notation as well as other record documents.
      - c. Complete understanding of the system ARCHITECTure and design of implemented solution.
      - d. Complete function and feature analysis on implemented solution including command line interface (CLI) including, but not limited to:

- (1) CLI Modes and sub-modes
- (2) CLI Hierarchy
- (3) CLI Commands
- e. A fault tree analysis to assist the service technician who troubleshoots and fix problems on implemented solution.
- f. Basic elements replacement procedures on implemented solution.
- g. Operating System configuration elements as-built
- h. VoIP and Network requirements and basics elements check list.
- i. maintenance and troubleshooting tools of implemented solution
- j. Support escalation and contact information on implemented solution

END OF SECTION

**PART 4 - ATTACHMENTS****4.01 ATTACHMENT A – LAN SYSTEMS CHECKLIST****A. Quality Assurance**

OWNER is to examine the following items based on the criteria defined in section 25805 (LAN Systems).

OWNER is to examine 100% of Backbone Switch, Edge Switch Managed, and Access Router. Other items shall be tested at a 10% rate. If deficiencies are noted the system shall be failed. OWNER shall consider continuing testing at a 20% rate to determine the integrity of the system.

<b>Installation Check List</b>	<b>Pass</b>	<b>Fail</b>
Are all CONTRACTOR furnished systems and related equipment installed as specified?	<input type="checkbox"/>	<input type="checkbox"/>
Backbone Switch (BBS)?	<input type="checkbox"/>	<input type="checkbox"/>
Intermediate Switch Managed (ISM)?	<input type="checkbox"/>	<input type="checkbox"/>
Edge Switch Managed (ESM)?	<input type="checkbox"/>	<input type="checkbox"/>
Compact Edge Switch Managed (CESM)?	<input type="checkbox"/>	<input type="checkbox"/>
Access Router?	<input type="checkbox"/>	<input type="checkbox"/>
Uninterruptible Power Supply (UPS)?	<input type="checkbox"/>	<input type="checkbox"/>
Unshielded Twisted Pair (UTP) Cables and interface modules?	<input type="checkbox"/>	<input type="checkbox"/>
Fiber Optic Cables and modules (multi-mode and/or single-mode)?	<input type="checkbox"/>	<input type="checkbox"/>
Are all required racks and cabinets installed as specified?	<input type="checkbox"/>	<input type="checkbox"/>
Is the BBS, and the ESMs, from a single manufacturer?	<input type="checkbox"/>	<input type="checkbox"/>
Have IP addresses and VLANs been configured on required systems?	<input type="checkbox"/>	<input type="checkbox"/>
Has SNMP been configured on all required systems?	<input type="checkbox"/>	<input type="checkbox"/>
Were all submittals provided as specified in section 1.03?	<input type="checkbox"/>	<input type="checkbox"/>
Has all documentation been provided as specified in sections 1.05.A.13 & B.4?	<input type="checkbox"/>	<input type="checkbox"/>

<b>Functionality Check List</b>		<b>Pass</b>	<b>Fail</b>
BBS:		<input type="checkbox"/>	<input type="checkbox"/>
Static IP Address Support?		<input type="checkbox"/>	<input type="checkbox"/>
Hot Swappable Power Supplies?		<input type="checkbox"/>	<input type="checkbox"/>
Remote Configuration Load via TFTP or FTP?		<input type="checkbox"/>	<input type="checkbox"/>
In-band configuration via Telnet and SSH?		<input type="checkbox"/>	<input type="checkbox"/>
Remote SNMP Management?		<input type="checkbox"/>	<input type="checkbox"/>
Configuration of VLAN Trunks and IEEE 802.1q Tags?		<input type="checkbox"/>	<input type="checkbox"/>
RMON Group 1 & 2 Statistics?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.1s Multiple Spanning Tree Domains?		<input type="checkbox"/>	<input type="checkbox"/>
Network Time Protocol (NTP) Support?		<input type="checkbox"/>	<input type="checkbox"/>
Logging to Report User Access, Configuration Changes, and System Events?		<input type="checkbox"/>	<input type="checkbox"/>
IP Multicasting (IGMPv2 and IGMP Snooping)?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.1p QoS?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.3ad Link Aggregation?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.3at or PoE+ Power over Ethernet?		<input type="checkbox"/>	<input type="checkbox"/>
ESM:		<input type="checkbox"/>	<input type="checkbox"/>
Static IP Address Support?		<input type="checkbox"/>	<input type="checkbox"/>
Hot Swappable Power Supplies?		<input type="checkbox"/>	<input type="checkbox"/>
Remote Configuration Load via TFTP or FTP?		<input type="checkbox"/>	<input type="checkbox"/>
In-band configuration via Telnet and SSH?		<input type="checkbox"/>	<input type="checkbox"/>
Remote SNMP Management?		<input type="checkbox"/>	<input type="checkbox"/>
Configuration of VLAN Trunks and IEEE 802.1q Tags?		<input type="checkbox"/>	<input type="checkbox"/>
RMON Group 1 Statistics?		<input type="checkbox"/>	<input type="checkbox"/>
Network Time Protocol (NTP) Support?		<input type="checkbox"/>	<input type="checkbox"/>
Logging to Report User Access, Configuration Changes, and System Events?		<input type="checkbox"/>	<input type="checkbox"/>
IP Multicasting (IGMPv2 and IGMP Snooping)?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.1p QoS?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.3ad Link Aggregation?		<input type="checkbox"/>	<input type="checkbox"/>
IEEE 802.3at or PoE+ Power over Ethernet?		<input type="checkbox"/>	<input type="checkbox"/>
Access Router:		<input type="checkbox"/>	<input type="checkbox"/>
Static IP Address Support?		<input type="checkbox"/>	<input type="checkbox"/>
Provides DHCP Services for IP Devices at Local Site?		<input type="checkbox"/>	<input type="checkbox"/>
Provides NTP Services for IP Devices at Local Site?		<input type="checkbox"/>	<input type="checkbox"/>
Hot Swappable Power Supplies?		<input type="checkbox"/>	<input type="checkbox"/>
Remote Configuration Load via TFTP or FTP?		<input type="checkbox"/>	<input type="checkbox"/>

Functionality Check List	Pass	Fail
In-band configuration via Telnet and SSH?	<input type="checkbox"/>	<input type="checkbox"/>
Remote SNMP Management?	<input type="checkbox"/>	<input type="checkbox"/>
Access Control-based Security Model (e.g., ACLs)?	<input type="checkbox"/>	<input type="checkbox"/>
RMON Group 1 & 2 Statistics?	<input type="checkbox"/>	<input type="checkbox"/>
IPsec with NAT and PAT?	<input type="checkbox"/>	<input type="checkbox"/>
SNA over IP?	<input type="checkbox"/>	<input type="checkbox"/>
Logging to Report User Access, Configuration Changes, and System Events?	<input type="checkbox"/>	<input type="checkbox"/>
IP Routing using OSPF?	<input type="checkbox"/>	<input type="checkbox"/>
IP Multicast Routing using PIM?	<input type="checkbox"/>	<input type="checkbox"/>

## SECTION 27 5128

**AUTONOMOUS PUBLIC ADDRESS SYSTEMS  
(AUDITORIUMS, PERFORMING ARTS, MULTI-PURPOSE ROOMS  
MIDDLE AND HIGH SCHOOL)**

**PART 1 - GENERAL****1.01 SUMMARY**

- A. Principal items of Work in this Section include but are not limited to:
1. Autonomous public address (PA) sound system in auditoriums of middle and high schools.
  2. Conductors and terminal strips to provide for functions and requirements, including interface cabling to PA/Intercom system.
  3. Provide labor, engineering, design, testing, materials, components, and supervision necessary to provide a complete operable installation.
- B. Related Requirements:
1. Division 01 - General Requirements.
  2. Section 26 0500: Common Work Results for Electrical.
  3. Section 26 0513: Basic Electrical Materials and Methods.
  4. Section 26 0526: Grounding and Bonding.
  5. Section 26 0519: Low Voltage Wires (600 Volt AC)
  6. Section 26 0533: Raceways and Boxes Fitting and Supports.
  7. Section 26 2416: Panelboards and Signal Terminal Cabinets.
  8. Section 27 1013: Structured Cabling (Existing Facilities).
  9. Section 27 5116: Public Address and Intercommunication Systems.
  10. Section 27 5127: Autonomous Public Address Systems (Small Gyms, Multipurpose Rooms, ES).
  11. Section 27 5129: Autonomous Public Address System (Gymnasiums).

C. Acronyms:

DTMF Dual Tone Multiple Frequency  
IC Intercom  
LCD Liquid Crystal Display  
OAR Owner Authorized Representative  
PA Public Address  
PABX Private Auxiliary Branch Exchange  
TDS Time Domain Spectrometry  
MLS Maximum Length Sequence Measurement Technique or Analyzer

1.02 SYSTEM REQUIREMENTS

- A. Reproduction shall be attained at sound levels sufficient to override noise levels typical for schools, to provide a satisfactory and serviceable system.
- B. Audio level of telephone intercommunication system shall be attained at sound levels sufficient to override noise levels typical for schools, to provide a satisfactory and serviceable system with a minimum of 70dB isolation between public address and intercommunication signals.
- C. Entire system shall be supported by engineering documentation including:
  1. Floor plans indicating devices, conduit runs, wire types, and terminal cabinets.
  2. Block diagrams indicating items and their point-to-point connections in a manner following floor plan layout.

1.03 SUBMITTALS

- A. Submit the following:
  1. Provide catalog cuts, technical data, and descriptive literature on components. Data shall be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data.
  2. Submittals shall be bound and shall contain an index organized vertically by assembly and item number and horizontally by columns.
    - a. The first assembly shall be the major head end equipment.
    - b. The leftmost column shall be the item number; next shall be the description, followed by the applicable specification section number,

- and followed by the specified item, which is followed by the submitted item.
- c. The rightmost column shall be for notes, which shall be used to reference the reason for submitting items other than as specified.
  3. Submittals shall contain product data sheets or catalog cut sheets for each item listed in the Index. These shall be arranged in the same order as the index and if more than one item is shown, the submitted items shall be highlighted or marked with an arrow.
    - a. The product data shall be sufficiently detailed to allow the Architect to evaluate the suitability of the product and to allow other trades to provide necessary coordination.
  4. Provide Shop Drawings, in the same size as the Record Drawings. Shop Drawings shall be prepared in latest version of AutoCAD with three CD-ROM electronic copies submitted along with full sized Shop Drawings.
    - a. Provide a complete set of scaled drawings of racks, consoles, and cabinets with designations, dimensions, color, operating controls, instrument wiring, and schematic diagrams of circuits, following Drawings as baseline.
    - b. Shop Drawings shall provide details as to interfaces of equipment of other Work, identifying numbers of wires, termination requirements, voltages, and other pertinent details. Include front elevations, cabinet dimensions, types of mounting, doors, barriers, catalog number of locks, and finishes for terminal cabinets.
    - c. Include a dimensional Shop Drawing of console nameplate. Nameplate shall contain school name, firm, address, telephone number for warrantee and maintenance, and power load.
    - d. For Signal Terminal Cabinets: (Refer to Structured Cabling Specification, Section 27 1514) Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.
    - e. Shop drawings shall indicate equipment locations, wiring and schematics, details, panel configurations, sizes and a point-to-point wiring diagram of all circuits. Shop drawings shall indicate interfaces to equipment furnished by others, identifying numbers of wires,

termination requirements, and other pertinent details. Responsibility for each end of interfaces shall be noted on shop drawings.

- f. Submit Drawings prepared, signed, and sealed by structural engineer licensed in the State of California. Details shall be provided indicating the proposed means of support and attachment of speakers and all wall and floor mounted racks. Calculations shall be based on the maximum seismic loads as determined by the CBC based on specifications provided by the cabinet manufacturer.
- 5. Permits and Inspections: Obtain and pay for required permits and inspections, deliver certificates of inspection to the Project Inspector.
- 6. Installer shall have completed at least five projects of equal scope to systems described herein and shall have been in the business of supplying and installing specified type of systems for at least five years. Installer shall include the telephone number of the customer's client contact for each project
- 7. Installer shall include in the Material List Submission copies of the manufacturers' certifications that the Installer is an authorized distributor and service provider of the submitted manufacturers' products and Installer's staff has been adequately trained and certified in the installation of those products.
- 8. Installer shall provide a letter from the Manufacturer warranting the availability of spare parts common to proposed system for a period no less than five years on all components
- 9. Calculations: Power load of PA system shall be calculated by the Installer on a separate sheet and shall be included in submittal.
- 10. Design Analysis: Installer shall submit an electro-acoustical design analysis for review. Provide scale drawings indicating plans and sections of the auditorium along with an elevation of the cluster. One drawing shall indicate contours with the maximum predicted sound pressure level for the 1KHz octave with a band limited pink noise test signal. Another drawing shall indicate the calculated area within which the specified electro-acoustic frequency response may be maintained for the first arrival sound from the cluster. Submit the name and the organizational affiliation of the individuals responsible for performing the electro-acoustical design analysis. Submit evidence, including appropriate certificates, that these individuals are trained in the specified modeling application. The design shall be generated by or based upon the output of a Computer Aided Electro-Acoustical Design Program such as Ease, Acosta CADD, Bose Modeler, Array SHOW, CATT, JBL CADP2 OR MAPP Online Pro.

## 1.04

## CODES AND STANDARDS

- A. Complete installation shall meet or exceed the latest edition of following standards.
1. EIA/TIA-568: Commercial building telecommunications wiring standard.
  2. EIA/TIA-569: Commercial building standard for telecommunications pathways and spaces.
  3. EIA/TIA-606: Administration standard for telecommunications infrastructure of commercial buildings.
  4. EIA/TIA-607: Commercial building grounding and bonding requirements for telecommunications.
  5. CCR Part 2 - California Building Code (CBC).
  6. CCR Part 3 - California Electrical Code (CEC).
  7. ANSI, ASTM, UL, NEMA, IEEE and FCC standards as applicable.
  8. BICSI Telecommunications Distribution Methods Manual, current edition.

#### 1.05 SYSTEM DESCRIPTION

- A. The system shall consist of a fully operational autonomous Public Address system that provides loudspeaker coverage for Auditoriums within Schools. The system shall consist of multiple input, output and amplification components integrated into a school operational system.

#### 1.06 QUALITY ASSURANCE

- A. Work shall conform to CCR, Title 24 Part 3, Basic Electrical Regulation and National Electrical Code, latest edition.
- B. Only a qualified Installer holding licenses required by legally constituted authorities having jurisdiction over the work, shall do the work.
- C. Persons skilled in trade represented by work, and in accordance with all applicable building codes, shall install system in accordance with best trade practice.
- D. Work shall be performed by an installer that has completed at least five school systems of equal scope to system described herein and shall have been engaged in business of supplying and installing specified type of systems for at least five years. Installer shall maintain a fully equipped service organization capable of furnishing repair service to equipment
- E. Use adequate numbers of skilled technicians who are manufacturer and CTS certified, thoroughly trained and experienced on the necessary crafts and completely familiar

- with the specified requirements and methods needed for the proper performance of the work.
- F. Coordinate cable runs, and rack equipment locations with the OAR during the initial design of the cable installation. Installer and OAR must agree as to the final location of devices and the cable plant design.
- G. Provide manpower and tools required to participate in Owners Quality Assurance Testing as detailed in Appendix "A" of this specification.
1. Items on check list of Appendix "A" will be examined as a minimum at the Public Address Head End, terminal cabinets, ground vaults and classrooms. Should the examination show deficiencies related to items in the checklist, Owners acceptance testing will be discontinued until corrections have been made. When an Installer has completed the corrections, a subsequent Quality Assurance test shall be initiated. This procedure is in addition to the system functionality testing required in Article 3.02 below.
- H. Design analysis shall be performed by certified individuals under the direct observation of the sound engineer responsible for preparation of the Shop Drawings.
- I. Perform system startup and electro-acoustical testing with the TDS Techron TEF20 instruments under the direct observation of the sound engineer responsible for preparation of the Shop Drawings. Alternatively, an MLS analyzer such as Acoustisoft ETP 5 Acoustisoft, RPlusD, EAW Smaart or Meyer Sound SIM System 3 may be used to perform the testing. Use all manufacturer recommended options with any of these programs.

## 1.07

**WARRANTY**

- A. Warranty that work executed and materials furnished shall be free from defects in materials, fabrication and labor for a minimum period of three years from date of installation acceptance, excluding specific items of work that require a warranty of a greater period as set forth in this Specification. In the event a manufacturer's warranty is longer than three years, the manufacturer's warranty shall be the warranty period. Immediately upon receipt of written notice from the Owner, repair or replace at no expense to the Owner, any defective material or work that may be discovered before final acceptance of work or within warranty period; any material or work damaged thereby; and adjacent material or work that may be displaced in repair or replacement. Examination of or failure to examine work by the Owner shall not relieve Contractor from these obligations.

**PART 2 - PRODUCTS**

## 2.01

**ANTENNA AND GROUNDING**

**A. Antenna and Accessories:**

1. FM Antenna: Provide a Blonder Tongue BTY-2-FM, or equal, all-direction FM dipole antenna on the indicated roof location. Lead-in cable shall be 72 ohm weatherproof coaxial type, furnished with necessary weatherproof matching transformer at each end. Cable shall be Belden 8241, or equal. Provide and install a weatherproof surge protector, PolyPhaser, or equal with # 6 AWG grounding conductor to a grounding electrode. The grounding conductor shall be bonded to the mast and surge protector.
2. AM Antenna: Furnish a whip type AM antenna. Insulate antenna from ground. Guy AM antenna whip from mast with an insulated standoff. If signal strength is not adequate from the antenna to provide interference-free reception, provide and install a 30-foot length of hard-drawn 12 gage copper wire between new roof antenna masts. Lead-in wire shall be 72 ohm coaxial cable Belden 8241, or equal, and furnished with necessary matching transformers at each end. Provide and install a weatherproof surge protector, PolyPhaser, or equal with # 6 AWG grounding conductor to a grounding electrode. The grounding conductor shall be bonded to the mast and surge protector.
3. Provide an AM/FM antenna coupler in an outdoor housing mounted on antenna mast. Rauland No. LM0027 or equal.
4. Provide an antenna mast on the roof of the administration building or as indicated on Drawings. Mast shall be 1 ¼-inch galvanized steel and shall be secured to roof joists with steel straps specifically manufactured for specified installation.
5. Provide a ¾ inch antenna conduit from PA console to antenna.

**B. Grounding:**

1. Wiring enclosures, terminal cabinets, outlets, frames of cabinet racks, and other enclosures shall be grounded in accordance with the requirements of the California Electrical Code, as specified, or required.
2. Chassis of amplifiers, power supplies, and accessories shall be grounded by being bonded to the control cabinet.
3. Housing, grips of all microphones, conductive housings, and other equipment shall be grounded by means of grounding wire or shield in cord or cable furnished for equipment connections.
4. Circuits shall be grounded as recommended by manufacturer of equipment to which they are connected unless otherwise specified or required.

- A. Microphone receptacles shall be Cannon XLR/SLR Series, or equal. Receptacles shall be furnished with mounting brackets for floor boxes, Sierra, or equal, 0.040 inch stainless steel plates, unless noted otherwise on Drawings. Plates shall be engraved with receptacle function in 3/16 inch high letters filled with black paint. Receptacles shall conform to following:

<u>Type</u>	<u>Description</u>	<u>Model</u>
(A)	Single microphone, male.	LR-3-14, on a one-gang plate receptacle wall mounting.
(B)	Microphone receptacle, male.	Appleton Model RE-725, or ceiling-mounted on a manual Reelite Retractable reel with take-up reel, Belden No. 8412 cable, or equal, and Cannon XLR Series plug and support chain.
(C)	Single microphone, male.	LR-3-14N, with a CA015-0094-000, receptacle floor mounting yoke.

- B. Projector receptacles shall be Switchcraft No. D4F or equal and mounted on a Sierra S 13 single-gang stainless steel plate or on a yoke or insert in a floor box.
- C. Speaker connectors shall be Neutrik two- or four-conductor jacks specifically provided for the specified installation. Stage monitor speaker jacks shall be furnished with one jack on a Sierra No. S-13 plate. Cluster speakers shall be furnished with jacks as required on a custom, brushed, anodized, engraved and filled aluminum plate mounted on a six inch by six inch by 12-inch screw cover box. Connectors for the assistive listening system FM antenna and the central system override speaker shall be located on this panel. Flush or surface mounting condition and finish shall be as required by Architect.

## 2.03 CONDUCTOR/CABLES

- A. Cable for overriding autonomous PA system shall be one twisted pair, No. 18 conductor; West Penn No. CL2 293 or equal. The furnished cable shall be the same type of cable furnished for zone paging, switching, and interfacing.
- B. Cable for microphone and other input sources and speakers shall be one twisted pair of 22 gage stranded tinned copper conductors, polyethylene shielded with an aluminum foil-mylar shield, a 22 gage stranded tinned copper drain wire and polyvinyl jacket. Cable shall be Belden 8761, or equal.
- C. Power cables to speakers in the cluster shall be one jacketed, twisted, stranded 12 AWG pair, West Penn CL3 227, or equal.

10/01/11

INSTALLATION OF 7 RELOCATABLE BUILDINGS

BIRMINGHAM COMMUNITY CHARGER HIGH SCHOOL (AUDITORIUMS, PERFORMING ARTS, MULTI-PURPOSE ROOMS,

PUBLIC ADDRESS SYSTEMS

MS AND HS)

27 5128-8

- D. Coaxial cables from wireless microphone antennas to antenna splitters and from assistive listening transmitter to antenna shall be RG-58 A/U, Belden 8219, or equal.

2.04      **KEYS AND LOCKS**

- A. Provide keys and locks for cabinets and equipment; locks shall be keyed to a Corbin No. 60 key, for access to operate equipment and Corbin No. 70 key, for access to service equipment.

2.05      **AUDITORIUM AUTONOMOUS PA SOUND SYSTEM**

- A. System shall provide the following functions:

1. Selective inputs for microphones, central sound rack, projector, AM-FM tuner/cassette tape player and output jacks for a tape recorder with tone, volume, and mixer controls on front panel.
2. "Program All" and "Emergency All" audio shall be reproduced in the auditorium over loudspeakers through parallel speaker system and a relay activated by central console under these conditions. During "program all" and "emergency all" autonomous speakers are automatically disconnected from the Auditorium PA amplifiers using the relay and a speaker load placed on output of that amplifier to prevent damage so that a feed from central sound console to the parallel central sound system may be heard. Alternatively, muting the amplifier at the input or by power disconnection is acceptable.
3. Auditorium PA system shall provide a line level output to central console.
4. On program transmission mode to or from auditorium PA system, following operations shall be provided:
  - a. Local PA system shall be manually energized before transmission. If one of the amplifiers and/or mixers is connected to an "always-on" ac outlet, this may not be necessary.
  - b. "From" line: Program from central PA system is manually switched to local amplifier input and audio level adjusted with local amplifier volume controls.
  - c. "To" line: Program to central PA system is manually switched to local amplifier output and locally originated program is transmitted to central PA console.
  - d. "TO" or "FROM" switch shall be located on amplifier front panel.

- B. System Components:

1. Equipment shall be contained in a freestanding cabinet, with matching sides and top panel, providing at least 78 ¾-inch panel space and furnished with a louvered rear door with recessed handle and lock. Exterior rack dimensions shall be 87 ¾-inch high by 22-1/8-inch wide by 22 1/8-inch deep. Rack shall be furnished with key locking steel front and rear doors. The rack shall be constructed of 16-gage steel. Cabinet shall be constructed with mounting rails tapped for No. 10-32 screws on EIA spacing front and rear, and shall be provided with CBC compliant earthquake reinforcing kits. Calculations for seismic bracing shall be based on the maximum seismic loads as determined by the CBC based on specifications provided by the cabinet manufacturer. Cabinet shall be UL listed.
2. Program for digital mixer-preamplifier shall be a TOA D-901- rack mount digital stereo mixer, or equal, with four stereo line inputs, six microphone/line inputs, six mix busses, a stereo output, a sum of stereo mono output, one auxiliary output and one monitor output. The mixer shall not occupy more than three rack spaces.
3. Automatic microphone mixer/pre-amplifier shall be a TOA M-9000, or equal, with modular inputs as required. It shall be possible to link up to five mixers together into one unit and the system shall provide an adjustable number of open microphone (NOM) circuits to allow optimization of gain sharing for each situation.
4. AM-FM tuner shall be a TOA DT-930, or equal, with 40AM and/or FM presets, three uV FM/26 uV AM sensitivity, and -8dB unbalanced mono output. Tuner shall not occupy more than two rack spaces.
5. CD player shall be a Marantz No. PMD371, or equal, five disk rotary changer with IR remote control. Features shall include full random play, single or multiple track repeat change disks while playing, index access via remote control audible cue and review, full programming and program editing, automatic music search and AMX controller computability.
6. Digital Sound Processors shall be furnished with two 64-bit processors, 24-bit A/D and D/A converters, and firmware upgradeable functionality. It shall be furnished with two-channel, 31-band, 1/3 octave equalization and three bands per channel of parametric equalization and shall have six bands of automatic feedback elimination. The processors shall be furnished with real-time analyzer capability with automatic equalization adjustment and dual channel, multi-band limiter, and dual channel noise gate and digital delay. Digital audio processors shall be Behringer DEQ 2496, or equal.
7. Rack-mounted equipment shall be identified by engraved designations mounted either on the vent or blank panels above or below the equipment or on designations mounted between the mounting screws on each side. The

10/01/11

INSTALLATION OF 7 RELOCATABLE BUILDINGS

PUBLIC ADDRESS SYSTEMS

BIRMINGHAM COMMUNITY CHARGER HIGH SCHOOL (AUDITORIUMS, PERFORMING ARTS, MULTI-PUPOSE ROOMS;

MS AND HS)

27 5128-10

designations on the rack shall match those indicated on the Shop Drawings. Designations are to be engraved in  $\frac{1}{4}$  inch high white letters on black micarta stock. Bevel the edges of designations.

8. Dual-channel power amplifiers for loudspeakers: Amplifier shall be provided with a minimum FTC output power rating of 500 watts/channel into eight ohms at less than 0.25 percent THD from 20Hz to 20KHz. Hum and noise shall be -100 dB or better referred to rated power output into eight ohms. Amplifier shall be furnished with thermal, short circuit and clipping protection. Provide one amplifier channel for every two horn speakers, at a minimum, and provide a controller module, if specified by the manufacturer, appropriate to the associated loudspeakers for each amplifier to optimize array performance. Amplifier shall be Electro-Voice P2000, Apogee Sound CA8000 or QSC CX902. Amplifier and array speakers shall be the products of one manufacturer. A subwoofer, such as the TOA F120B/W may be added to the system if it can be appropriately attached to one of the existing amplifier outputs.
9. Auditorium Loudspeakers: Quantity, selection of coverage patterns and locations shall be as required to provide specified levels and uniformity of coverage for first arrival sound over the required coverage area. Loudspeaker shall be available with a minimum coverage pattern of 60 by 40 degrees and shall provide a minimum frequency range of 50 Hz to 15 KHz. Speaker shall have sensitivity of at least 95 dB, 1w, 1m at 1KHz. Speakers shall be Electro-Voice Fri+152 series, Apogee AFI-3 or Ohm Ltd B-15 or equal. The frequency response for first arrival sound from the cluster within the specified coverage area as measured with a Techron TEF 20 shall be plus and minus four dB from 60Hz to 15KHz when a 1/3 octave smoothing function is applied. Amplifier and speakers shall be the products of one manufacturer.
10. Flying hardware to hold the cluster speakers together shall be as required by the manufacturer.
11. Dual-channel power amplifier for the booth monitor speakers shall be a Sampson Servo 200, or equal, with 100 watts per channel into four ohms.
12. Booth monitor speakers shall be Tannoy No. Di5 point source, or equal, dual concentric single drive, induction coupled full range loudspeaker, not requiring any electronic processor or control unit. The speaker, without control unit, shall provide a frequency response of plus or minus four dB 125Hz to 20khz when measured on axis with 1/3 octave smoothed swept signal. The sensitivity shall be 90 dB at 1m with 2.83 volts applied signal. Maximum sound pressure level shall be 110 dB SPL at 1m on axis with band limited noise. An output jack shall be provided on the rack front to allow recording. Connect as appropriate to an amplifier or line-level output.

10/01/11

13. Type C1 horn loudspeakers shall be Atlas No. APC-30T or equal. Speakers shall be used in conjunction with the autonomous system override controlled by the central system PA system.
  14. Preprogram at least two preset configurations into the D-901 (and/or the Behringer DSPs). Label each to allow one setup for optimum voice intelligibility, and the other for music. Label the rack to indicate the two preset buttons, one for VOICE and the second MUSIC. Provide an explanation during the training sessions as to the proper operation of these two presets.
- C. A wireless microphone sub-system shall be furnished and shall accommodate a total of ten microphones. The antenna splitters and wireless microphone receivers shall be mounted in a wall-mounted rack back stage, in close proximity to the diversity receiver antennas. The system shall be furnished with ten wireless lapel microphones and four hand held wireless microphones. Any combination totaling ten microphones may be used at one time. Provide the following:
1. Wireless microphone receivers shall be Telex FMR-500, or equal, UHF true diversity receiver with  $\leq 1.0\text{mv}$  RF sensitivity, 90dB of squelch quieting and hum and noise-90dB. Two units shall mount in one rack space and the antennas shall be removable for use with antenna splitters.
  2. Wireless microphone splitters shall be Telex APD-4, or equal.
  3. Wireless receiver antenna shall be Telex ANU-14, or equal,  $\frac{1}{4}$  wave antenna mounted for optimal signal reception from the stage and forestage.
  4. Wireless belt pack transmitter shall be Telex WT-500, or equal, with metal case and TA-4 connector.
  5. Lavalier microphone shall be an ELM-22S, or equal, omni-directional condenser microphone with aTA-4F connector.
  6. Hand-held wireless microphone shall be a Telex HT-500, or equal, with EV 767 super cardioid dynamic microphone element.
- D. Production Intercom System:
1. System shall be microprocessor controlled with two-party line channels and 12 VDC phantom power. The rack-mounted controller shall be furnished with "TALK", "LISTEN" and "TAB" keys for each channel, an "ALL-TALK" key and a "PA" key. The rack-mounted power supply shall furnish a two amp power supply and an amplified 5W speaker. The system shall be provided with wall-mounted intercom and speaker stations. Furnish one single-sided headset and one 30-foot headset extension cable for each station, including the rack mount controller.

10/01/11

INSTALLATION OF 7 RELOCATABLE BUILDINGS

PUBLIC ADDRESS SYSTEMS

BIRMINGHAM COMMUNITY CHARGER HIGH SCHOOL (AUDITORIUMS, PERFORMING ARTS, MULTI-PUPOSE ROOMS;

MS AND HS)

27 5128-12

2. Component/Accessory Manufacturers:
  - a. Intercom controller shall be Telex US-2002, or equal.
  - b. Intercom power supply shall be a Telex SPS-2001, or equal.
  - c. Wall-mounted, two-channel intercom station shall be Telex WM-2000, or equal.
  - d. Wall-mounted, two-channel intercom speaker station shall be Telex SS-2002, or equal.
  - e. Single-sided headset shall be Telex PH-1, or equal.
  - f. Headset extension cables shall be Telex HE-30, or equal.
- E. Hearing Assistance System: FM hearing assistance system shall be as manufactured by Williams Sound, Phonic Ear, or equal, and shall be furnished with the following components:
  1. No. PPA-375 base station mounted inside the amplifier cabinet. The base station shall operate in 72 MHz-76MHz band and shall be furnished with remote-mounted antenna to cover a minimum of 500 feet.
  2. No. PPA-R35 single channel receiver for use by the listener with standard n-style headset connection including headphones.. Receiver shall be capable of being clipped to a pocket or belt. Unit shall be furnished with two AA rechargeable nickel Metal Hydride batteries with receivers furnished at 100:4 ratio of seats in the auditorium to receivers provided, but never less than two receivers. Deliver receivers to the OAR before Substantial Completion.
  3. Number CHG-3512 battery charger organizer. Unit shall be capable of storing or recharging up to 12 receivers at one time. The charger shall be capable of recharging the nickel Metal Hydride batteries without removing the batteries from the receiver. Battery chargers shall be furnished in sufficient quantity to charge all provided receivers simultaneously, and transmitted to the OAR before substantial completion.

## 2.06 PORTABLE EQUIPMENT

- A. Provide four, low-impedance, dynamic cardioid microphones with floor stand. Microphone shall be a Shure Type SM 58, or equal, with on/off switch and microphone holders. Microphones will be furnished with 15-foot Shure microphone cables. The floor stands shall be Atlas MS-20, or equal.

- B. Provide one, 100-foot, one-piece microphone extension cable. Provide two cables, 20 gage, shielded, Belden No. 8412, or equal, terminated with Cannon No. XLR-3-11C and No. XLR-3-12C plugs.
- C. Provide eighteen, Switchcraft No. 20QD20N0, two-foot long, 1/4 inch tip, ring, sleeve patch cords.
- D. Portable equipment shall remain in the manufacturer boxes and shall be transmitted to the OAR before Substantial Completion.

### PART 3 - EXECUTION

**3.01 AUTONOMOUS PUBLIC ADDRESS SYSTEM (AUDITORIUMS)  
INSTALLATION**

- A. Console and Cabinet Rack Equipment Installation: Equipment within consoles and cabinet racks shall be logically arranged for convenient accessibility and maintenance. Equipment shall be mounted on shelves or panels and shall be securely attached.
- B. Amplifiers, power supplies, and other heavy devices shall be mounted in the lowest available rack spaces on steel shelves fabricated by manufacturer of console and cabinet racks. Amplifiers and other heavy components shall be mounted in the lowest usable spaces in the rack. Cabinets, consoles, and panel faces including drawers shall be the same color.
- C. Wiring within console and cabinets shall be installed to conform to standard engineering practice, and shall be terminated on terminal strips having a terminal for each required external connection. Wiring shall be cabled, laced, and securely fastened in place so no weight is imposed on any equipment, control switches, or terminals. Wires carrying audio power shall be shielded. Input and output circuits and terminal strips shall be installed to provide separation necessary for proper operation. Wires shall be identified by number and chart.
- D. Conductor shields for each system shall be grounded at one location only. Grounding shall be provided within console and cabinet racks. There shall be no metallic connection between systems. Conduits for system and 120 volt AC system shall be bonded together at console and all cabinet racks.
- E. Terminate 120 volt AC supply conductors directly on disconnect switches specified and in required raceway.

**3.02 OWNERS QUALITY ASSURANCE CERTIFICATION AND TESTING**

- A. Provide instruments for testing, and demonstrate in the presence of the Owner that the circuits and wiring test free of shorts and grounds.

10/01/11

INSTALLATION OF 7 RELOCATABLE BUILDINGS

PUBLIC ADDRESS SYSTEMS

BIRMINGHAM COMMUNITY CHARGER HIGH SCHOOL (AUDITORIUMS, PERFORMING ARTS, MULTI-PUPOSE ROOMS;

MS AND HS)

27 5128-14

- B. Provide labor, instruments, appliances, equipment, and materials necessary to demonstrate to the Owner the installation performs as required.
- C. Owner has the right to perform independent tests of equipment furnished, to determine whether or not equipment complies with requirements specified, and to proceed based on results obtained.
- D. The system shall be fully tested and operational before final inspection. Test results shall be provided to the Owner before final inspection.
- E. System startup and electro-acoustical testing with the Techron TEF20 instrumentation (or equivalent MLS system) shall be performed under the direct observation of the engineer responsible for preparation of the Shop Drawings.
- F. Reproduction of speech shall be clear, high fidelity, and with all frequencies within range of system faithfully reproduced without detectable noise, hum and distortion.
  - 1. With 0 dBm sine wave test signal applied at a line input of the TOA D-901 program mixer, with gain adjusted so that the sum of stereo electronically balanced output has a 0 dBm output, and with the Digital Signal Processor bypassed, demonstrate that each channel of the Cluster Amps can deliver 250 watts RMS or greater into an 8 ohm resistive load from 80Hz to 10,000 Hz within their respective bandwidths, (below 250 Hz for the low-frequency amp, above 250 Hz the high-frequency amp). Record measurements at 80Hz, 125Hz, 200Hz, 315Hz, 315Hz, 1KHz, 3.15KHz, and 10KHz for each amplifier.
  - 2. With setup and gain adjusted as specified above, short the balanced line input with a 620 ohm resistor; 20KHz band limited noise at any cluster amp channel output shall be 80 dB below the level required to produce 250 watts RMS. Record the measured noise level for each line input to a given high-frequency cluster AMP output.
  - 3. With setup and gain adjusted as specified above and with a 500Hz test signal, measure the total harmonic generation and noise (TH&G) throughout the audio chain. THG&N shall be 0.25 percent or less. Record the THG&N for each line input to a give high-frequency cluster amplifier channel. Record the THG&N from given line input to each high frequency cluster amplifier channel.
  - 4. With a 500Hz, 1mV sine wave signal applied to a microphone input of the TOA D-901 program mixer, with the gain adjusted so that the sum of stereo electronically balanced output has a 0 dBm output, with the digital signal processor bypassed, adjust the level of a given high-frequency cluster amplifier to deliver 250 watts RMS into an eight ohm resistive load. Record the THG&N for each microphone input to a given high-frequency cluster amplifier channel output. THG&N shall be 0.25 percent or less.

5. With setup as specified above, short the input with a 120 ohm resistor and measure the 20 KHz band limited noise at the output. 20KHz band-limited noise shall be 80 dB below the level required to deliver 250 watts RMS into an eight ohm resistive load. Record the noise level for each microphone input to the given High Frequency Cluster Amplifier channel output.
6. From a selected line level input to the effects amplifier outputs perform the measurements described above, except adjust the amplifier to deliver 100 watts RMS into an eight ohm resistive load.
7. Perform measurements of first arrival sound pressure levels to verify compliance with the reviewed design analysis. System shall be capable of producing first arrival levels of 90 dB SPL over the specified 40Hz to 17KHz frequency spectrum in the center of the last row of fixed seating and in more than 90 percent of the fixed seats when measured with the Techron TEF-20 electro-acoustical test equipment. One-third octave smoothed first frequency response is plus and minus four dB over the specified 40Hz to 17KHz spectrum and plus and minus two dB from 100Hz to 10KHz in more than 90 percent of the fixed seats. First arrival requirements do not apply to areas in the acoustical shadow of columns, etc. Provide full TEF contours at six locations to provide the Architect with information on which to base recommendations for acoustical treatment.
8. Perform two recordings of ambient noise testing with the HVAC system turned both on off. Provide test documentation to the Architect and indicate any unusual noise spikes or bands in the frequency domain caused by the HVAC.

### 3.03 PROJECT RECORD DOCUMENTS

#### A. As-Built Documentation:

1. Provide three copies size E (30-inch by 42-inch) of Project site and building plans, indicating location of equipment, conduit, cable routing, ground vaults terminal cabinets, pull boxes and other installation information.
2. Provide two copies of the record Drawings in .DWG format prepared using the most recent version of AutoCAD on a labeled CD-ROM for use on a Windows platform.
  - a. LAUSD utilizes layers as a key tool in controlling visibility of drawing elements and to provide consistent information between drawings, yet provide control over what is seen on each sheet. Public Address wiring shall be shown on a separate layer, labeled as "Public Address" that uses both building floor plans and conduit supporting structure layers below. The use of any version control blocks or company logos shall be on a layer separate from the premise wiring as-built drawings.

3. Floor plans indicating all devices, terminal cabinets and cross connect locations, conduit runs, ground vaults, wire types, cable routing of all cables, both underground and in each building with conduit fill and count, and as-built coding used on each cable.
  - a. Drawings shall include block diagrams indicating all items and their point-to-point connections in a manner following floor and site plan layout. Drawings shall also include as-built single line diagram, cable site plot plan and floor plans indicating all cables, both underground and in each building with conduit, and as-built coding used on each cable
  - b. Floor plans shall indicate all devices, terminal cabinets and cross connect locations, conduit runs, ground vaults, wire types, cable routing of all cables, both underground and in each building with conduit fill and count, and as-built coding used on each cable

B. Operating and Servicing Manuals, Record Drawings:

1. Deliver three copies of operating and servicing manual. Each complete manual shall be bound in three ring binders and all data shall be typewritten or drafted.
  - a. Manuals shall include a page with Project site and Project name, date of Substantial Completion, Contractor's name, address, telephone, and fax numbers.
  - b. Manuals shall contain a letter, signed by an officer of the company indicating the beginning and ending date of any warranties described in Article 1.07 of this specification and shall describe the companies' commitment to service the warranty during the terms specified.
  - c. Manuals include as-built floor plans indicating all cables, both underground and in each building with conduit, and as-built coding used on each cable. Drawings Size A (8 ½ by 11) and size B (11 by 17) shall be bound into the manual. Larger drawings shall be folded and inserted into transparent envelopes bound into the manual. Programming forms of each system shall be submitted with complete information.
  - d. Manuals shall include all instructions necessary for proper operation and servicing of system and shall include:
    - 1) A single line diagram of the system indicating items and their point-to-point connections in a manner following floor and site plan layout.

- 2) A complete two wire diagram of all connections made between components inside the system console.
- 3) A wiring destination schedule for each circuit leaving console and each rack.
- 4) All custom fabricated circuits, components and connections not detailed in the manufacturer's manuals shall have wiring diagrams detailing to component level, the manner in which the circuits are connected.
- 5) A schematic diagram of each amplifier and other components, transistor complements and replacement part numbers.

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.06 OWNER ORIENTATION

- A. Before contract completion, provide and arrange for a manufacturer's technical representative to instruct designated Owner personnel in correct operation of system. Instruction shall be provided on the Project site and shall be a minimum of four hours.
- B. Instruction shall be based on manufacturers written operating instructions covering those features of interest to the Owner and applicable to the Work.

10/01/11

INSTALLATION OF 7 RELOCATABLE BUILDINGS

PUBLIC ADDRESS SYSTEMS

BIRMINGHAM COMMUNITY CHARGER HIGH SCHOOL (AUDITORIUMS, PERFORMING ARTS, MULTI-PPOSE ROOMS;

MS AND HS)

27 5128-18

**ATTACHMENT "A"**  
**Safety and Technology Owners Quality Assurance**

**Site Location****Code / Name** \_\_\_\_\_**Network****Engineer** \_\_\_\_\_ **Project Inspector** \_\_\_\_\_**PM** \_\_\_\_\_**Recommendation** \_\_\_\_\_ **Electrical** \_\_\_\_\_

Owner is to examine the following items based on the criteria defined in this Section. If deficiencies are noted, the system will be failed. As a courtesy, Owner will consider continuing testing at a 20 percent rate to determine the integrity of the system.

<b>Autonomous Public Address System Check List</b>	<b>Pass</b>	<b>Fail</b>
Check all conduit and raceway layout and installation for each low voltage systems and verify that they meet all project specifications and Record Documents.	<input type="checkbox"/>	<input type="checkbox"/>
Examine Head-end equipment installation, cable cross connection, system configuration for compliance with specification and conformance to Record Documents.	<input type="checkbox"/>	<input type="checkbox"/>
Equipment rack installation, including placement in the communications room, seismic bracing and attachment to the floor are in conformance with specification and Structural Engineers Submittal Drawings.	<input type="checkbox"/>	<input type="checkbox"/>
Are all cables clearly and indelibly marked?	<input type="checkbox"/>	<input type="checkbox"/>
Is the cross-connect field clearly marked?	<input type="checkbox"/>	<input type="checkbox"/>
Are all terminations punched down singly and cross-connected?	<input type="checkbox"/>	<input type="checkbox"/>
Has a wiring index and destination chart been placed within the system console?	<input type="checkbox"/>	<input type="checkbox"/>
Ensure that all active components, terminal cabinets, cross connects are located in a secure location.	<input type="checkbox"/>	<input type="checkbox"/>
Verify that "program transmission modes" to Main Public Address/Intercom Console are fully functional.	<input type="checkbox"/>	<input type="checkbox"/>
Verify that all-call override is in place and functions per Specification.	<input type="checkbox"/>	<input type="checkbox"/>
Verify the functionality of the hearing assistance system. Consider coverage with the room and quality of sound.	<input type="checkbox"/>	<input type="checkbox"/>
Important Note: Failure on any category, constitute failure of the entire system		

END OF SECTION

**SECTION 31 2316**  
**EXCAVATION AND FILL FOR PAVING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Excavating, backfill, and compacting for paved areas.
2. Installation of fill materials.

**B. Related Requirements:**

1. Division 01 - General Requirements.
2. ~~Section 01 4524 - Environmental Import/Export Material Testing.~~
3. ~~Section 31 1000 - Site Clearing.~~
4. ~~Section 31 2200 - Grading.~~
5. Section 31 2323 - Excavation and Fill for Utilities.
6. Section 32 2326 - Base Course.
7. ~~Section 32 0117 - Pavement Repair.~~
8. Section 32 1216 - Asphalt Paving.
9. Section 32 1313 - Site Concrete Work.

**1.02 PROJECT REQUIREMENTS**

**A. Import and Export of Earth Materials:**

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

**1.03 SUBMITTALS**

**A. Imported Soils:** A geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain initial product Sample for testing in accordance with the terms of Article 3.05 of this section.

1.04        **QUALITY ASSURANCE**

- A. Comply with Standard Specifications for Public Works Construction, current edition, except as modified herein.
- B. Sampling, testing, and certification of imported and/or exported soils shall be performed in accordance with Section 01 4524 - Environmental Import/Export Material Testing.

1.05        **PROJECT CONDITIONS**

- A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.
- B. A copy of the foundation investigation and soils report is available for examination at the Architect's office during regular office hours of Architect.

**PART 2 - PRODUCTS**2.01        **BASE MATERIALS**

- A. Concrete Slabs On Grade: Provide "Crushed Aggregate Base" as specified in the Standard Specifications for Public Works Construction, Section 200: "Rock Materials," with  $\frac{3}{4}$  inch maximum size aggregates. Provide 3-inch thick base, unless noted otherwise.
- B. Bituminous Surfacing: As indicated on Drawings and specified in Section 31 2326 - Base Course.

2.02        **FILL AND BACKFILL MATERIALS**

- A. Fill and backfill materials shall be previously excavated materials or imported fill material, free of clods and stones larger than 3-inch, foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.
- B. Fill material exhibiting a wide variation in consistency and moisture content shall be blended or aerated to stabilize and upgrade the material.
- C. Imported Fill Material:
  1. Provide suitable materials obtained from Project site excavations for earthwork and fill materials. If excavated materials are not of suitable quality or sufficient quantity, import additional materials as necessary.
  2. Imported fill shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing 200 mesh sieve. Material shall have a coefficient of expansion of not more than 2 percent from air dry to optimum moisture content and not more than 6 percent from air dry to saturation. Imported material shall be

clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.

- D. Other Fill Materials: Brick rubble and broken concrete originating from the Project site may be legally disposed of off the Project site or incorporated in fill, if reviewed by a geotechnical engineer, retained by the Owner as an Owner Consultant. Unless otherwise required, no such materials may be imported from outside the Project site.
- E. Permeable Backfill:
  - 1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:

Sieve Size:	Percentage Passing:
3/4 inch (19mm)	100
3/8 inch (10mm)	80 to 100
No. 100	0 to 8
No. 200	0 to 3

  - 2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.
  - 3. Provided backing for weep holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.
  - 4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system, Miradrain by Mirafi, Inc., or equal, may be provided if reviewed by the Architect.

### PART 3 - EXECUTION

#### 3.01 SITE PREPARATION

- A. Clear the Project site as required in Section 31 1000 - Site Clearing.

#### 3.02 PROTECTION

- A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, Cal-OSHA regulations.
- B. Protect adjacent existing improvements including landscaping against damage.

#### 3.03 EXISTING UTILITY LINES

- A. Protect existing utility lines from damage or displacement.

- B. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of 2 feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.

**3.04 EXCAVATION**

- A. Unclassified Excavations: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.

**3.05 FILL**

- A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.
- B. Provide fill materials as specified in Part 2 - Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.
- C. In addition to the requirements of this section, import and/or exported materials shall comply with the requirements of Section 01 4524 - Environmental Import/Export Material Testing.
- D. Imported fill materials shall be sampled by a geotechnical engineer, retained by the Owner as an Owner Consultant, for compliance with the requirements of Part 2 of this Section.
- E. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall submit samples to a DSA approved independent approved testing laboratory for testing.
- F. Initial sampling shall be performed by the geotechnical engineer, retained by the Owner as an Owner Consultant, before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain both the initial and additional samples from the identified site and shall submit samples to the approved independent testing laboratory for testing.
- G. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing tested for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.
- H. The independent approved testing laboratory shall perform the required tests and report results of tests noting if the tested material passed or failed such tests and shall furnish copies to the Project Inspector, Architect, OAR, DSA, Contractor, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in

accordance with applicable provisions of the Contract Documents, CBC, and the DSA. Upon completion of the Work of this section, the independent testing laboratory and geotechnical engineer shall submit a verified report to the DSA as required by CBC.

- I. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.
- J. Upon completion of import operations, provide the OAR a certification statement attesting that imported material has been obtained from the identified source site.

### 3.06 INSTALLATION OF MATERIALS

- A. Fill or backfill materials shall be installed in horizontal layers of 6 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the geotechnical engineer, retained by the Owner as an Owner Consultant, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but no more than 1 in 20. Provide adequate drainage at all times during construction of the Work of this section.

### 3.07 COMPACTING

- A. Each layer of fill material shall be compacted by tamping, sheepsfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.
- B. Unless otherwise indicated, compact each layer of earth fill to a relative compaction of at least 90 percent.
- C. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each compacted layer before installing the next succeeding layer.

### 3.08 INSPECTION AND TESTING

- A. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavations, sample material quality as required in Part 2, and observe installation and compaction of fill materials.
- B. The geotechnical engineer, retained by the Owner as an Owner Consultant, will sample imported fill materials from their designated source before delivery to the Project site.
- C. Installation of backfill shall be observed by the geotechnical engineer, retained by the Owner as an Owner Consultant.
- D. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavation Work before the installation of fill and/or other materials.

E. Compaction: Test compaction in accordance with ASTM D1557, Method C.

3.09 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.10 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 31 2323**  
**EXCAVATION AND FILL FOR UTILITIES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Excavating, backfilling, and compacting utility trenches such as water, gas, irrigation, storm drain, sewer lines, concrete-encased conduits, and manholes, vaults, valve boxes, catch basins, underground tanks, thrust blocks, yard boxes, pull boxes and other utility appurtenances.

**B. Related Requirements:**

1. Division 01 - General Requirements.
2. ~~Section 01 4524 Environmental Import/Export Material Testing.~~
3. ~~Section 31 1000 Site Clearing.~~
4. ~~Section 31 2200 Grading.~~
5. ~~Section 31 2316 Excavation and Fill for Paving.~~
6. ~~Section 31 2319 Excavation and Fill for Structures.~~
7. ~~Section 32 0117 Pavement Repair.~~
8. Section 32 1313 - Site Concrete Work.
9. ~~Section 32 8413 Potable Water Irrigation.~~
10. ~~Section 32 8426 Reclaimed Water Irrigation.~~
11. ~~Section 33 1100 Site Water Distribution Utilities.~~
12. ~~Section 33 3000 Site Sanitary Sewer Utilities.~~
13. ~~Section 33 4000 Storm Drainage Utilities.~~
14. Division 22 - Plumbing.
15. Division 26 - Electrical.

**1.02 PROJECT REQUIREMENTS**

**A. Import and Export of Earth Materials:**

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

#### 1.03 SUBMITTALS

- A. Imported Soil: A geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain initial product Sample for testing in accordance with the terms of Article 3.05 of this section.

#### 1.04 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement: Standard Specifications for Public Works construction, current edition except as modified herein.
- B. Sampling, testing, and certification of imported and/or exported soils shall be performed in accordance with Section 01 4524 - Environmental Import/Export Material Testing.

#### 1.05 PROJECT CONDITIONS

- A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.
- B. A copy of the foundation investigation and soils report is available for examination at the Architect's office during regular business hours of Architect.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Bedding material from trench bottom to one foot above the pipe:
  1. Sand, gravel, crushed aggregate or native free-draining granular material providing a sand equivalent of at least 30 or a coefficient of permeability greater than 1.4 inches per hour.
  2. Sand complying with the Specifications for cement concrete aggregates.
- B. Backfill Materials:
  1. Excavated trench material to be installed for backfilling shall be clean, free of large clods, and stones larger than 2 ½-inch in any dimension.
  2. Cement-sand slurry shall be provided with one sack of cement per cubic yard of the mixture.

3. Imported Fill Material: Imported fill material shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing a 200 mesh sieve. Material shall provide a coefficient of expansion of not more than two percent from air dry to optimum moisture content and not more than six percent from air dry to saturation. Imported materials shall be clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Before excavation, contact the "Underground Service Alert of Southern California" (USASC) for information on buried public utilities and pipelines. For on-site utilities retain an underground locating service.
- B. Barricade trenches, ditches, pits, sumps, and similar Work outside the barricaded working area with chain link fence as specified in Section 01 5000 - Construction Facilities and Temporary Controls, and in accordance with Cal-OSHA standards and requirements.
- C. Saw-cut concrete or bituminous paving for trench installation.
- D. Trenches over 5 feet in depth shall conform to the Cal-OSHA.
- E. Where indicated and required to excavate in lawn areas, protect adjoining lawn areas outside of the Work area. Replace or install removed sod upon completion of backfill by installing sod level with adjacent lawns. If installation of removed sod fails, furnish sod and install to match existing lawns.
- F. Backfill over excavations to the required elevations with earth, gravel, sand, or concrete and compact as required. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. Slope adjacent grades away from excavations to minimize entry of water.
- G. Do not install piping lengthwise under concrete walks without review by the Architect.
- H. Do not excavate trenches parallel to footings closer than 18 inches from the face of the footing or below a plane having a downward slope of two horizontal to one vertical, from a line 9 inches above bottom of footings.
  - I. Unless otherwise indicated on Drawings, depth of excavations outside the buildings shall allow for a minimum coverage above top of pipe, tank, or conduit measured from the lowest adjoining finished grade, as follows:

Steel Pipe	24 inches below finished grade
Copper Water Tube	18 inches below finished grade
Cast-Iron Pressure Pipe	36 inches below finished grade

Plastic Pipe (other than waste)	30 inches below finished grade
Tanks or other structures	36 inches below finished grade
Soil, Sewer & Storm Drain	minimum 18 inches below finished grade, and as required for proper pitch and traffic load. (Install polypropylene sewer pipe with at least 24 inches coverage)
Irrigation Pipe:	nonpressure pipe 12 inches, pressure pipe 24 inches

2. Trench width shall provide ample space for fitting and joining. Excavate for piping bells and fittings, bell and spigot pipe and other fittings.
- I. Unless indicated otherwise, excavate trenches to the required depths for utilities, such as pipes, conduit and tanks, with minimum allowances of 6 inches at the bottom and 6 inches at the sides for bedding of unprotected piping or as required for concrete encasement of conduits as indicated on Drawings. Grade bottom of trenches to a uniform smooth surface. Remove loose soil from the excavation before installing sand bedding or concrete encasement.
  - J. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed soil and fill as required. Slope adjacent grades away from excavations to minimize entry of water.
  - K. Provide a minimum clear dimension of 2 inches from sides of wall excavation to outer surfaces of buried pipes or conduits installed in the same trench or outside surfaces of containers and tanks.
  - L. Do not install backfill until required inspections and testing is completed.
  - M. Backfill electrical or other excavated utility trenches located outside of barricaded installation areas within 24 hours after inspection by the Project Inspector.
  - N. Install backfill materials in layers not exceeding 4 inches in thickness and compact to 90 percent of the maximum density.
  - O. If materials excavated from the Project site are not permitted for trench backfill in paved areas, backfill trenches with a cement-sand slurry mix. Install backfill to an elevation of the existing undisturbed grade plus one inch.
  - P. Install and compact sand bedding to provide a uniform full length bearing under piping and conduits.
  - Q. Where portions of existing structures, walks, paving, or other improvements are removed or cut for piping or conduit installation, replace the material with equal quality, finished to match adjoining existing improvements. Repair pavement as specified in Section 32 0117 - Pavement Repair.

### 3.02 IMPORT/EXPORT OF MATERIALS

- A. Provide fill materials as specified in Part 2- Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.
- B. In addition to the requirements of this section, import and exported materials shall comply with the requirements of Section 01 4524 - Environmental Import/Export Material Testing.
- C. Imported fill materials shall be sampled by a geotechnical engineer, retained by the Owner as an Owner Consultant, for compliance with the requirements of Part 2 of this section.
- D. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform the tests by utilizing an independent approved testing laboratory.
- E. Initial sampling shall be performed by the geotechnical engineer, retained by the Owner as an Owner Consultant, before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall obtain both the initial sample and additional samples from the identified site and shall submit all samples to the approved independent testing laboratory.
- F. The geotechnical engineer, retained by the Owner as an Owner Consultant, shall perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.
- G. The independent approved testing laboratory shall perform the required tests and report results of all tests noting if the tested material passed or failed such tests and shall furnish copies to the Project Inspector, Architect, OAR, DSA, Contractor, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, CBC and the DSA. Upon completion of the Work of this section, the independent testing laboratory and geotechnical engineer shall submit a verified report to the DSA as required by CBC.
- H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.
- I. Upon completion of import operations, provide the OAR a certification statement attesting that imported material has been obtained from the identified source site.

## 3.03

## INSPECTION AND TESTING

- A. The geotechnical engineer, retained by the Owner as an Owner Consultant, will inspect and test excavations, sample material quality as required in Part 2, observe installation and compaction of fill materials.

- B. Compaction test shall be performed in accordance with ASTM D1557, method "C."

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 31 2326**  
**BASE COURSE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Installation of base material.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. ~~Section 31 1000 - Site Clearing.~~
  - 3. ~~Section 31 2200 - Grading.~~
  - 4. ~~Section 31 2313 - Excavation and Fill.~~
  - 5. ~~Section 31 2316 - Excavation and Fill for Paving.~~
  - 6. ~~Section 32 0117 - Pavement Repair.~~
  - 7. Section 32 1216 - Asphalt Paving.
  - 8. Section 32 1313 - Site Concrete Work.

**1.02 SUBMITTALS**

- A. Prior to import, submit written certification to OAR that crushed Miscellaneous Base (CMB) does not contain Polychlorinated biphenyls (PCB) above laboratory detection limits when tested in accordance with EPA Method 8082, and obtain written approval from LAUSD-OEHS prior to import at the subject site, refer to Article 2.02 for sampling frequency.
- B. Crushed aggregate base (CAB) shall consist of native rock without naturally occurring asbestos or recycled materials. The Contractor shall submit written documentation, which identifies the source, volume, and proposed transport date of the material for review and approval by LAUSD-OEHS prior to importing the material. A statement on company letterhead from the source, stamped by either a California Professional Geologist or Engineer, which states that the subject materials are native rock, do not contain any recycled materials and that the source does not mine ultramafic materials, a source of natural occurring asbestos shall be included in the submittal to OEHS. The Contractor may request variance from testing by Section 01 4523 for CAB. To be considered for a variance, the Contractor shall submit a documentation package, which includes all of the aforementioned information at least 48 hours in advance of planned import.

- 1. Frequently used suppliers:

- a. Hansen Aggregates.
  - b. Vulcan Materials, Reliance Company.
  - c. Vulcan Materials Durbin.
- C. Product Data: Submit material source, technical information and test data for base materials. Gradation and quality certifications shall be dated within 30 days of the submittal.
- D. Sample: Submit Sample of proposed base course material.

#### 1.03      **QUALITY ASSURANCE**

- A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction, current edition.

### **PART 2 - PRODUCTS**

#### **2.01      UNTREATED BASE MATERIALS**

- A. The following base materials shall conform to the requirements of the Standard Specifications for Public Works Construction: Section 200 - Rock Materials.
- 1. Crushed Aggregate Base.
  - 2. Crushed Miscellaneous Base.
    - a. CMB meeting requirements of Article 1.02, A, may be used on-site for pavement base only.
    - b. CMB may be used off-site when in accordance to the Greenboook.

- B. Materials generated on site shall not be used as a base course material.

#### **2.02      SOURCE QUALITY CONTROL**

- A. Sampling and testing of imported and/or exported crushed miscellaneous base (CMB) shall be performed in accordance with the following Table 1 schedule:

TABLE 1: MINIMUM SAMPLING FREQUENCY	
Volume (CY)	Sampling Frequency
0 to 500	1 per 100 Cubic Yards
501 to 1,000	1 per 250 Cubic Yards
1,001 to 5,000	1 per 250 Cubic Yards for first 1,000 Cubic Yards 1 per 500 CY thereafter
5,001 to 20,000	12 samples for first 5,000 Cubic Yards 1 per 1,000 Cubic Yards thereafter
over 20,000	1 per 2,000 Cubic Yards for first 20,000 Cubic Yards 1 per 2,500 CY thereafter

## 2.03 MATERIAL APPROVAL

- A. Base material shall be inspected by the Project Inspector for gradation and material content prior to installation. The owner may choose to have additional tests performed by a geotechnical engineer, retained by the Owner, before installation.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install base course material in layers not exceeding 4 inches in thickness, unless required otherwise. Grade and compact to indicated levels or grades, cut and fill, water and roll until the surface is hard and true to line, grade and required section. Provide a relative compaction of at least 95 percent, unless otherwise required.
- B. Grade base course to elevations indicated on Drawings, ready to receive surfacing, in accordance with Section 31 2200 - Grading.

### 3.02 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

### 3.03 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

## END OF SECTION

**SECTION 32 1216**  
**ASPHALT PAVING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Paving for playground, parking areas, areas between buildings, synthetic track surfacing adjacent to planting and turf areas as indicated.

B. Related Requirements:

1. Division 01 - General Requirements.
2. ~~Section 31 2200 - Grading.~~
3. ~~Section 32 0117 - Pavement Repair.~~
4. Section 31 2326 - Base Course.
5. Section 32 1236 - Seal for Bituminous Surfacing.
6. Section 32 1313 - Site Concrete Work.

**1.02 SUBMITTALS**

- A. Shop Drawings: Submit site plan indicating extent of paving and accessories.
- B. Product Data: Manufacturer's technical data for materials and products.

**1.03 QUALITY ASSURANCE**

- A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction.

**1.04 PROJECT CONDITIONS**

- A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.
- B. A copy of the soils report is available for examination in the office of the Architect during regular office hours of the Architect.

**PART 2 - PRODUCTS**

**2.01 BITUMINOUS MATERIALS**

- A. Provide materials of the class, grade, or type indicated on the Drawings, conforming to relevant provisions of Section 203 - Bituminous Materials of the Standard Specifications for Public Works Construction.

## 2.02

## HEADERS

- A. Concrete: Per specification Section 32 1313 - Site Concrete Work.
- B. Wood:
  1. Redwood, Construction Heart Grade, size 2 by 6, unless otherwise indicated.
  2. Stakes: 2 by 4 redwood or 2 by 3 Douglas fir, Construction Grade.
  3. Nails: Common, galvanized, 12d minimum.

## PART 3 - EXECUTION

## 3.01

## HEADERS

- A. Install headers along edge of bituminous surfacing abutting turf, earth, or planting area, unless indicated otherwise.
- B. Install headers so the bottom surface has continuous bearing on solid grade. Where excavation for headers is undercut, thoroughly tamp soil under the header. Compact backfill on both sides of header to the density of adjacent undisturbed earth.
- C. Where wood headers are indicated on drawing, fasten headers in place with redwood or Douglas fir stakes of length necessary to extend into solid grade a minimum of 12 inches. Stakes shall be of sound material, neatly pointed, driven vertically, and securely nailed to headers. Space stakes, not to exceed 4 feet on center with top of stakes set one inch below top of header. Provide a minimum of two 12d galvanized common nails through each stake.
- D. Remove existing headers where new surfacing is installed adjacent to existing surfacing.
- E. Install temporary headers at transverse joints of paving where continuous paving operations are not maintained.
- F. Provide additional stakes and anchorage as required to fasten headers in place.

## 3.02

## CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

- A. Thickness of Surfacing: Unless otherwise indicated on Drawings or specified, install bituminous surfacing to a compacted thickness of 2 inches.
- B. Provide surfacing material over base course as specified in Section 31 2326 - Base Course.

- C. Surfaces of walls, concrete, masonry, or existing bituminous surfacing indicated to be in direct contact with installed bituminous surfacing shall be cleaned, dried and uniformly coated with an asphaltic emulsion film.
- D. Thicken edges of bituminous surfacing that do not abut walls, concrete, or masonry, and edges joining existing bituminous surfaces. Remove headers at existing bituminous surfacing where new bituminous surfacing is to be installed. Thicken edges an additional 2 inches and taper to the indicated or specified thickness 6 inches back from such edges.
- E. At stairways, adjust thickness of paving such that the first tread is equal in height to all other treads.
- F. Provide adequate protection for concrete, planting areas, and other finish Work adjacent to areas indicated to receive bituminous surfacing.
- G. Placing:
  - 1. Do not install bituminous surfacing when atmospheric temperature is below 40 degrees F; or when fog or other unsuitable weather conditions are present. Temperature of mixture at time of installation shall not be lower than 260 degrees F in warm weather or higher than 320 degrees F in cold weather.
  - 2. Where 2-inch or 3-inch thick surfacing is indicated or specified, install surfacing in one course. Where surfacing is indicated or specified 4 inches or more in thickness, except for thickened edges, install bituminous surfacing in courses of approximately equal thickness, each course not exceeding 2  $\frac{1}{2}$  inches in thickness.
- H. Stakes or Screeds: Provide grade or screed stakes spaced not more than 15 feet apart in flow lines with grades of less than one percent. Continuous screeds may be provided instead of stakes.
- I. Spreading: Install bituminous surfacing in a manner to cause least possible handling of mixture. In open areas and wherever practicable, install by mechanical means with a self-propelled mechanical spreader. In confined or restricted areas, install mixture with hot shovels and rakes, and smooth with lutes.
- J. Joints: Provide vertical joints between successive runs. Install joints true to line, grade, and cross section. Lapped joints are not permitted.
- K. Rolling:
  - 1. Finish roll with a self-propelled tandem roller weighing at least 8 tons. Break down roll with a self-propelled roller weighing between 1  $\frac{1}{2}$  tons and 8 tons.
  - 2. Roll in a manner that preserves flow lines and the established finished grades. Break down roll in areas adjacent to flow lines parallel to flow lines. Break down roll after bituminous surfacing is installed without shoving or cracking of mixture under roller. Continue finish rolling until surfacing is unyielding, true to grade, and meets requirements for specified smoothness. Areas inaccessible to finish roller may be finish rolled with breakdown roller or

tamped with hot tamping irons and smoothed with hot smoothing irons or hand roller.

3. Where bituminous surfacing abuts concrete, masonry, walks or paving, tamp joint smooth, if necessary, as described above to obtain a uniformly even joint, true to line and grade. Tamper and smooth to properly compact.
4. Compacted bituminous surfacing shall be provided with a bulk specific gravity of at least 2.31 when tested in accordance with ASTM D1188.

### 3.03 TOLERANCE

- A. Smoothness: Surface of bituminous surfacing after rolling, shall be even, smooth and uniform in texture with no voids or rock pockets, free of roller marks or other irregularities, and not varying by more than 0.03 foot, except at local depressions or raised areas as indicated, when a 10-foot straightedge is placed on surface.
- B. Grade: Finished grade shall not vary more than 0.02 foot above or below required grade. Variations within prescribed tolerance shall be compensating so that average grade and cross-section are provided.
- C. Premium paving tolerances and requirements for synthetic track:
  1. General: Test in-place asphalt concrete courses for compliance with requirements or thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Owner's representative.
  2. Thickness: Tolerances for thickness shall be  $\frac{1}{4}$  inch, plus or minus.
  3. Planarity: The asphalt substrate shall not vary from the planned cross slope by more than plus or minus 0.1 percent. The finished asphalt shall not vary, plus or minus, under a 10 feet straight edge greater than  $\frac{1}{8}$  inch. Flood test the surface with the use of a water truck. If, after 30 minutes on a 70 degree F day, "bird baths" are evident at a depth more than  $\frac{1}{8}$  inch repair using the best method of correction.
  4. Corrective Measures: Determine if the planarity, cross slopes, and general specifications have been met. If all of the conditions have been met notify the Owner in writing of the acceptance of the asphalt paving. [This notification must include the acceptance of the paving by the track surfacing contractor.]

### 3.04 TESTING

- A. After first coat of surface seal has been installed and after a 24 hour period, the flood test shall be completed of the bituminous surfacing in presence of the Project Inspector. Repair areas of standing water or puddles and flood test locally; install surface seal and retest as necessary.

### 3.05 SURFACE SEALING

- A. After bituminous surfacing has passed flood test, clear and allow to dry and provide one more coat of surface seal as specified in Section 32 1236 - Seal for Bituminous Surfacing.
- B. Where indicated, provide multiple coats of surface seal to existing bituminous surfacing.
- C. Where new bituminous surfacing joins existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.

3.06 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.07 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 32 1236**  
**SEAL FOR BITUMINOUS SURFACING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Surface sealer over bituminous surfacing.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - ~~2. Section 32 0117 - Pavement Repair.~~
  - 3. Section 32 1216 - Asphalt Paving.
  - ~~4. Section 32 1723 - Pavement Marking.~~

**1.02 SUBMITTALS**

- A. Product Data: Submit manufacturer's product information and application procedures for bituminous surfacing.

**1.03 QUALITY ASSURANCE**

- A. Comply with the Standard Specifications For Public Works Construction, current edition.
- B. Agitate bulk materials during transport.

**1.04 MAINTENANCE**

- A. Extra Materials: Provide 10 gallons in unopened containers.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Provide one of the following surface seals:

<u>Product Name</u>	<u>Manufacturer</u>
1. Guard-Top	CALMAT / Industrial Asphalt
2. Over Kote	Diversified Asphalt Product

- |    |                  |                             |
|----|------------------|-----------------------------|
| 3. | Park Top         | Western Colloid Products    |
| 4. | Sure Seal        | Asphalt Coating Engineering |
| 5. | Super Drive Top. | SAF-T Seal. Inc.            |
| 6. | Equal.           |                             |

### **PART 3 - EXECUTION**

#### **3.01 SURFACE PREPARATION**

- A. Thoroughly wash surfaces with water to remove dirt, debris, excessive oil and grease, or other foreign matter.

#### **3.02 APPLICATION**

- A. Install seal coat in strict accordance with manufacturer's written directions and recommendations.
- B. Install two coats of surface seal to new bituminous surfacing. First coat shall be installed before flood testing. Clean surface and allow to dry before installing second coat. Second coat shall be installed after bituminous surfacing has passed flood test.
- C. Where new bituminous surfacing is installed adjacent to existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.
- D. Where existing bituminous surfacing is indicated to be patched and sealed, install two coats of surface seal after patching. Refer to Section 32 1216 - Asphalt Paving.

#### **3.03 PROTECTION OF SURFACES**

- A. Protect sealed and unsealed surfaces from damage and traffic during performance of the Work of this section and until surface seal has thoroughly set and cured. Do not permit traffic of any kind for at least 24 hours after completion of installation.
- B. Protect the Work of this section until Substantial Completion.

#### **3.04 TESTING**

- A. Owner reserves the right to obtain samples, perform tests to ensure compliance with the Specifications, and to review weight slips and invoices of materials delivered to the Project site.

#### **3.05 CLEAN UP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

**END OF SECTION**

**SECTION 32 1313**  
**SITE CONCRETE WORK**

**PART 1 - GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Portland cement concrete pavement, cement walks, curbs, gutters, trash pick-up area, ramps, mowing strips, fence post footings, sliding gate concrete tracks, catch basins, pipe bedding and encasements, thrust blocks, transition structures, flagpoles and light standard bases and footings, athletic equipment footings and equipment pads.

B. Related Requirements:

1. Division 01 - General Requirements.
- ~~2. Section 01 3593 - Off-site Improvement Procedures.~~
- ~~3. Section 01 3596 - Off-site Improvement Procedures (B Permit).~~
4. Section 03 2000 - Concrete Reinforcement.
3. Division 23 - HVAC.
4. Division 26 - Electrical.
- ~~5. Section 31 2200 - Grading.~~
- ~~6. Section 31 2313 - Excavation and Fill.~~
- ~~7. Section 31 2316 - Excavation and Fill for Pavement.~~
8. Section 31 2326 - Base Course.
- ~~9. Section 32 0117 - Asphalt Pavement Repair.~~
10. Section 32 1216 - Asphalt Paving
11. Section 32 3113 - Chain Link Fences and Gates.
- ~~12. Section 33 1100 - Site Water Distribution Utilities.~~
- ~~13. Section 33 3000 - Site Sanitary Sewer Utilities.~~
- ~~14. Section 33 4000 - Storm Drainage Utilities.~~

**1.02 SUBMITTALS**

- A. Shop Drawings: Submit plans, elevations and details of concrete site Work.
- B. Product Data: Submit mix designs and manufacturer's technical data for materials and products. Submit 3-inch by 3-inch concrete Sample of each specified color.
- C. Material Sample: Submit one concrete bumper to the Project Inspector for destructive testing.

#### 1.03           QUALITY ASSURANCE

- A. Comply with Standard Specifications For Public Works Construction.

### PART 2 - PRODUCTS

#### 2.01           MATERIALS

- A. Concrete, Mortar and Related Materials: Comply with applicable provisions of Standard Specifications for Public Works Construction, Section 201 - Concrete, Mortar and Related Materials:
  - 1. Concrete: 28-day compressive strength 2,500 psi, unless specified otherwise.
  - 2. Reinforcing Mesh: ASTM A185, 4 by 4/W1.4 by W1.4 welded wire mesh.
  - 3. Expansion Joint Filler: Preformed expansion joint filler, bituminous type, complying with ASTM D994.
- B. Form Materials:
  - 1. Side forms: Douglas fir, Construction Grade or Better or metal forms.
  - 2. Stakes: Douglas fir, Construction Grade or Better or metal stakes.
- C. Concrete Parking Bumpers:
  - 1. Precast concrete, smooth and free of pits and rock pockets, providing a minimum 28-day compressive strength of 3,500 psi. Size at least 7 ½-inch wide, 5 ½-inch high and 6-foot long. Reinforce with two #5 reinforcing bars. Provide 2 ¾-inch diameter pre-drilled holes for anchor installation.
  - 2. Bumper Anchors: Provide ½ inch diameter by 18-inch long galvanized steel pipe.
  - 3. Bumper Adhesive: Provide adhesive recommended by bumper manufacturer/installer for fastening bumpers to concrete pavement.

### PART 3 - EXECUTION

#### 3.01           CONSTRUCTION OF FORMS FOR CAST-IN-PLACE STRUCTURES

- A. Concrete Pavement: Install Portland cement concrete pavement in compliance with the Standard Specifications for Public Works Construction, Section 302- Roadway Surfacing.
- B. Miscellaneous Exposed Concrete: Install concrete curbs, walks, gutters, cross gutters, access ramps, driveways, catch basins, yard boxes, vaults and similar structures, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.
- C. Exposed Concrete Bases: Install bases, such as for post, flagpole, light standards and similar bases, in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.
- D. Post, flagpole, light standard footings below grade, underground conduit bedding, encasements, thrust blocks and similar structures may be placed directly in excavations conforming to the required sizes.
- E. Reinforcement installation and concrete placement, surface finishes, curing and removal of forms shall be performed in compliance with applicable provisions of Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction. Provide heavy broom finish at slopes exceeding six percent and medium broom finish at slopes up to six percent.

#### 3.02 INSTALLATION OF PARKING BUMPERS

- A. Install bumpers as indicated on the Drawings. On bituminous paving, install anchors through pavement and into the ground a minimum of 12 inches. On concrete pavement, install bumpers in a continuous bed of adhesive.

#### 3.03 CLEAN UP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

#### 3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

**SECTION 32 3113**  
**CHAIN LINK FENCES AND GATES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Chain link fences and gates as indicated.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 03 3000 - Cast-in-Place Concrete.
  - 3. ~~Section 31 1000 - Site Cleaning.~~
  - 4. ~~Section 31 2200 - Grading.~~
  - 5. ~~Section 31 2316 - Excavation and Fill for Paving.~~
  - 6. ~~Section 32 0117 - Pavement Repair.~~
  - 7. Division 26 – Electrical.

**1.02 SUBMITTALS**

- A. Shop Drawings: Submit dimensioned plans and details indicating extent of fences, locations of gates, and details of attachment and footings. Indicate means and methods for surface preparation and finishing.
- B. Certifications: Manufacturers material certifications in compliance with the ASTM standards referenced in this Section.

**1.03 REFERENCES**

- A. ASTM A392: Standard Specification for Zinc-Coated Steel Chain Link Fence Fabric.
- B. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- C. ASTM A824 – Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence.

- D. ASTM F552 - Standard Terminology Relating to Chain Link Fencing.
- E. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- F. ASTM F567: Standard Practice for Installation of Chain Link Fence.
- G. ASTM F626 - Standard Specification for Fence Fittings.
- H. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric.
- I. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
- J. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
- K. ASTM F1083: Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- L. ASTM F1184: Standard Specification for Industrial and Commercial Horizontal Slide Gates.
- M. ASTM F1664 – Standard Specification for Poly Vinyl Chloride (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence.
- N. ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction.
- O. UL 325 - UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems.

#### 1.04        QUALITY ASSURANCE

- A. Manufacturer: Company specialized in manufacturing chain link fence products with at least five years of experience.
- B. Fence Installer: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F567 and with at least five year experience.

### PART 2 – PRODUCTS

#### 2.01        CHAIN LINK FABRIC

- A. Galvanized Chain Link Fabric: Conforming to ASTM A392, Class 2 zinc coating, 2.00 ounces minimum per square foot of uncoated wire surface, hot-dipped galvanized after

weaving, and with top and bottom edges knuckled (kk). Tie wires and hog rings shall conform to ASTM F626, and shall be 9 gage and galvanized.

B. Chain Link Fabric Requirements:

1. Fabric for perimeter fencing and interior fencing shall be 9 gage woven wire with 2 inch mesh, unless otherwise specified.
2. For perimeter fences 16 feet high, the upper 8 feet of fabric may be 11 gage.
3. Fences 12 feet high or less shall be furnished with single width fabric.
4. Fabric for fencing on top of handball court shall be 9 gage wire minimum with 1 inch mesh.
5. Fabric for fencing of tennis courts shall be full height, single width, 9 gage by 1-3/4 inches mesh chain link fabric.
6. Installed fence fabric shall be free from barbs, icicles, or other projections. Fence fabric with such defects will be deemed defective Work.

**2.02 STEEL FENCE FRAMEWORK**

- A. Posts, Top Rails, Brace Rails and Gate Frames: Standard weight, galvanized, welded steel pipe conforming to ASTM F1083, Group IA Heavy Industrial Fence Framework, with a minimum yield strength of 30,000 psi. Minimum 1.8 Oz/ft<sup>2</sup> hot dipped zinc coating average for interior and exterior.
- B. Schedule of Posts, Rails, Bracings and Footings: Unless indicated otherwise on the drawings, shall be of sizes indicated on the following schedule.

Item	Height	Nominal Pipe Size (inches)	Outside Diameter (inches)	Weight (pounds per foot)	Footings	
					Diameter (inches)	Depth (inches)
Top Rail, Brace Rails and Transom Rails	Up to 10'-0"	1-5/8	1.660	2.27	N/A	N/A
	10'-1" to 16'-0"	1-7/8	1.900	2.72	N/A	N/A
Line Posts	Up to 6'-0"	2-3/8	2.375	3.65	12	24
	6'-1" to 8'-0"	2-3/8	2.375	3.65	12	36
	8'-1" to 10'-0"	2-7/8	2.875	5.80	12	36
	10'-0" to 16'-0"	3-1/2	3.5	7.58	14	60
	14'-0" to 16'-0"	4	4.000	9.12	14	60
Terminal, Corner, Angle & Pull Posts	Up to 8'-0"	2-1/2	2.875	5.79	12	36
	8'-0" to 10'-0"	2-1/2	2.875	5.79	14	42

Item	Height	Nominal Pipe Size (inches)	Outside Diameter (inches)	Weight (pounds per foot)	Footings	
					Diameter (inches)	Depth (inches)
	10'-1" to 16'-0"	3	3.5	7.58	14	60
Pedestrian Gate Posts	Up to 8'-0"	2-1/2	2.875	5.79	14	36
Gate Frames	Up to 8'-0"	1-1/2	1.900	2.72	N/A	N/A
Driveway Double-Leaf Swing Gate Posts: Opening						
Up to 17'-3-1/2"	Up to 8'-0"	3 1/2	4	9.11	16	42
17'-4" to 20'-3-1/2"	Up to 8'-0"	3-1/2	4	9.11	16	42

## 2.03 FITTINGS

- A. Fittings shall be malleable iron conforming to ASTM F626.
- B. Post Caps: Designed to fit snugly over posts with a minimum projection of 1-1/2 inches below top of posts. Post caps shall be manufactured with a curved top.
- C. Eye Tops: Designed to fit over line posts, and for through passage of top rail.
- D. Expansion Sleeve Couplings for Top Rails: Steel, 6 inches long, designed to fit tightly on inside of rail, fitted with raised center.
- E. Rail Ends for Top Rails and Brace Rails: With holes to receive 3/8 inch bolts for securing to rail end bands.
- F. Tension Bands and Bands for Securing Rail Ends: Mild steel flats, at least 11 gage x one inch, tension bands in gates shall be 11 gage by 1 inch. Bolts for use with tension bands and rail end bands shall be galvanized machined 3/8 inch by 1 1/2-inch.
- G. Tension Bars: Mild steel flats at least 3/16 inch by 3/4 inch.

## 2.04 TENSION WIRE

- A. 6 gage marcelled steel wire conforming to ASTM A824, Type II Class 5 zinc coated, 2.00 ounces minimum per square foot of uncoated wire surface. Wavy type wire is not acceptable.
- B. .
- C. Turnbuckles for installation with Tension Wires: Eye and hook type, drop forged steel, right and left hand threads, at least 3/8 inch screw diameter with at least 4 1/2-inches of take-up.

## 2.05 PAINT FOR GALVANIZING REPAIR

- A. Paints for Refurbishing Galvanizing: Organic zinc-rich paint conforming to ASTM A780. Paints used on the site shall be approved by OWNER's Office of Environmental health and Safety (OEHS).

## 2.06 GROUT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications "Rapid set Cement".

## 2.07 GATES

- A. General:
1. Gate framework shall be fabricated of tubular steel of sizes indicated on the drawings and conforming to ASTM F1083, Group IA, with a minimum yield strength of 30,000 psi. Joints at corners shall be miter cut and continuously welded to sides.
  2. Install fence fabric to side members with tension bars and tension bands as specified, spaced not more than 14 inches apart. Tension bars shall extend full height of gate. Install fence fabric to top and bottom members and to brace rail with wire ties as specified for top rails, spaced not more than 12 inches apart. Chain link fabric shall match adjacent fence system.
  3. Latches and Hinges: Weld gate latches and strikes to gate posts and frames. Weld OWNER provided hinges to posts. Weld 3 hinges on each post for swing gates more than 16 feet wide. Welding shall be performed before gate frames are galvanized, or welds shall be finished as specified below.
  4. Grind welds flush and smooth. Hot-dip galvanize fabricated parts after welding, or be protected by zinc-rich paint in conformance to ASTM A780.
  5. Electrically operated gates shall be manufactured and installed in accordance with the safety requirements of ASTM F2200 and UL325.
- B. Swing Gates: Galvanized steel welded fabrication in conformance with ASTM F900, fabric size and gage shall match fence. Positive locking gate latch shall be fabricated of 5/16 inch thick by 1 3/4 inch pressed steel galvanized after fabrication. Weldable hinges will be provided by OWNER.
- C. Horizontal Overhead Slide Gates: Shall be in conformance to ASTM F1184 Type I. Positive locking gate latch shall be fabricated of 5/16 inch thick by 1 3/4 inch pressed steel galvanized after fabrication. Provide manufacturer's standard overhead support

08/28/2017

beam/structure, track, rollers and accessories to support gate panel. The overhead support beam/structure shall be galvanized or shall receive proper corrosion protection.

- D. Cantilever Slide Gates: Shall be in conformance to ASTM F1184 Type II, Class 1. Positive locking gate latch shall be fabricated of 5/16 inch thick by 1 3/4 inch pressed steel galvanized after fabrication. Provide manufacturer's standard overhead beam/structure, track, rollers and accessories to support gate panel. Gates shall be designed and fabricated to open or close by applying an initial pull force no greater than 40 pounds. Positive locking latch fabricated of galvanized pressed steel. Galvanized steel drop bars shall be provided on with double gates. Provide safety protective guards for top and bottom external rollers.
- E. Cantilever Internal Roller Gates: Shall be in conformance to ASTM F1184 Type II, Class 2. Length of back frame support section shall be a minimum of 40 percent of the opening. Slide gates shall comply with the performance deflection criteria listed in ASTM F1184. Gates shall be designed and fabricated to open or close by applying an initial pull force no greater than 40 pounds. Internal truck assemblies shall be designed to handle the forces required for gate size opening and height.
- F. Polymer coated gate frames and gateposts shall match the coating type and color specified for the fence framework. Moveable parts such as hinges, latches and drop rods shall be field coated using a liquid polymer touch up.

#### 2.08 PRIVACY FENCE SLATS

- A. Flat tubular shape with bottom lock track fabricated of PVC material with UV inhibitors.
- B. Privacy Percentage Factor: [75%] [95%].

#### 2.09 CONCRETE

- A. Comply with requirements of Section 03 3000, Cast-in-Place Concrete. Provide normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3,000 psi, 4-inch slump, and one inch maximum size aggregate.

### PART 3 - EXECUTION

#### 3.01 EARTHWORK

- A. Refer to the following Sections for earthwork related work:
  - 1. Section 31 2200 - Grading.
  - 2. Section 31 2316 - Excavation and Fill for Paving.
  - 3. Section 32 0117 - Pavement Repair.

## 3.02 FRAMEWORK INSTALLATION

- A. Install fences as indicated on Drawings.
- B. Space fence posts at equal intervals between terminal, angle, corner, and gate posts, and not more than 10 feet apart measured from center to center of posts. In curved fence sections having a radius of 50 feet or less, space posts not more than 5 feet - 6 inches apart. Install posts so that top of eye of post caps are level with top of fabric.
- C. Install angle or corner posts at each change in direction of 15 degrees or more, at change of 5 percent or more in grade of fencing, and at the beginning and end of curved fence sections.
- D. Install terminal posts at ends of runs of fencing. Install gateposts on both sides of driveway and pedestrian gates. For double-leaf gates, net opening between gate posts shall be gate size as indicated on Drawings, plus 3 ½-inches; for single leaf gates, net opening shall be gate size plus 2 ½-inches.
- E. Embed posts into footing 6 inches less than the depth of the footing unless noted otherwise on drawings.
- F. Where a fence is to be installed on a curb, construct footings with top of footing level with the lower finish grade. Align posts, set plumb and true before placing footings. Remove splattered concrete from exposed pipe surfaces while concrete is still soft. In bituminous surfaced areas, install seal coat on top of concrete footings.
- G. Install fences with top rail. Top rail shall pass through eye tops and be secured at ends with rail-end fittings and bands.
- H. Install fences over 10 feet in height, in addition to top rail, with a full length horizontal mid-rail set at mid-height of fence and rigidly secured to posts with rail end fittings and bands.
- I. In fences higher than 10 feet, install brace rails at angles, corners, and terminals at 1/4 and 3/4 of fence height. Provide one horizontal brace rail in panels adjacent to terminal, angle, corner, and gateposts, install at mid-height of fence and rigidly secured to posts with rail end fittings and bands. Provide horizontal brace rails, as specified, in panels of curved sections having a radius of 50 feet or less. Brace rails are not required in fencing 4 feet or less in height.
- J. Provide a transom rail and fabric at top of pedestrian gate openings. Install transom rail 6 feet 8 inches above high point of grade at gate opening. Ends of transom rails shall be pinned or riveted to rail end fittings with 1/4 inch mild steel rivets. Pin or rivet shall go through rail and peen. Welding on rail ends is not permitted.
- K. Install bottom tension wire a minimum of 3 inches from grade for fencing and secure to fence posts with ties. Provide a turnbuckle for each 150 feet of wire or fractional part thereof. Turnbuckles are not required in runs of 15 feet or less. Install ends of tension

wires to posts in a manner to prevent slipping or loss of tension. Wrap should start from fence side of post. Turn end of wire around post tightly twisted at least three times around wire. At turnbuckles, wire through eye and tightly twist end at least three times around wire. Cut tail of bottom wire flush.

### 3.03 CHAIN LINK FABRIC INSTALLATION

- A. Install fence fabric on outward facing side of posts, except for tennis courts. Install fence fabric with top edge projecting above top rail of fence.
- B. Install bottom of fence fabric to clear finish grades, except on bituminous surface install 3/4 inch above such surface. Locally shape and trench ground surfaces where necessary to provide uniform top and bottom alignment of fence.
- C. Tightly stretch fabric and at terminal, pull corner, angle, and gateposts, secure with tension bars extending full height of fence. Secure tension bars to posts with bolted tension bands spaced not more than 14 inches apart.
- D. Bands and Ties: Install bands and ties in accordance with following schedule:
 

15 bands on 16 feet fence	16 ties on 16 feet fence
11 bands on 12 feet fence	12 ties on 12 feet fence
7 bands on 8 feet fence	7 ties on 8 feet fence
6 bands on 6 feet fence	6 ties on 6 feet fence
4 bands on 4 feet fence	4 ties on 4 feet fence
- E. Fasten fabric to line posts with wire ties spaced not more than 16 inches apart. Where 6 gage aluminum ties are furnished, hook the tie at both ends. Installation of hooked ties with links is not permitted.
- F. Fasten fabric to top rails, mid-rails, brace rails, with wire ties spaced not more than 18 inches apart. Bend back ends of tie wires so as not to be a hazard. At bottom tension wire, install hog rings spaced not more than 18 inches apart. Where 2 fabrics are furnished, lap the fabrics one mesh at mid-rail and tie both fabrics with 9 gage wire or 6 gage aluminum ties to midrails.

### 3.04 WELD GRINDING

- A. Grind all field welds smooth, clean off flux and spatter, damaged galvanizing removed, burrs and projections ground off, properly prepared, then heavily coated with galvanizing repair coating. Install coating in accordance with written recommendations of manufacturer.

### 3.05 ALTERATIONS TO EXISTING FENCING

- A. Resetting Fences:

1. Existing fences shall be reset where finish pavement is raised or lowered more than 6 inches from existing grade. Remove and reinstall entire fence assembly as specified in this Section.
  - a. Where the finish grade is raised 6 inches or less, cut and re-knuckle the existing fence fabric. Adjust tension wire and tie to fabric. Bottom of fence fabric shall be installed  $\frac{3}{4}$ " above finish grade.
  - b. Where the finish pavement is lowered 6 inches or less, demolish the fence footing flush with the finish grade and adjust the fabric and its attachments. Bottom of fence fabric shall be installed  $\frac{3}{4}$  inches above finish grade.
2. Where existing fencing posts are indicated to be removed, reset or relocated, remove posts including their concrete footings
  - a. Fill footing cavity with sand, compact and cap surface matching existing adjacent material.
  - b. Construct new concrete footings, as specified, in their designated location and set posts as indicated above in Framework Installation Article.
3. Bent posts, rails and accessories shall be replaced with new parts as specified to complete reinstallation. New materials shall closely match design of existing installation. Cut bent portion of posts and weld new sections of equal diameter and thickness. Install splice to inside of all welded section prior to welding. Previously repaired or welded posts shall be replaced.
4. Top rail is required in reinstalled fencing which does not have top rail in its existing condition. Install as specified for new installations.
5. Fabric Removal: Do not remove more than what can be replaced during one day unless a barricade, providing equal security, will be installed in its place. If freestanding temporary fence is used, it shall be clamped and wrap tied.
6. Remove and dispose of off-site concrete debris, chain link, hardware and accessories. Use new hardware and accessories.
7. Gates:
  - a. Remove non-welded type existing hinges and replace with OWNER provided weldable hinges. On existing welded hinges remove bolts and replace with new. Remove existing latches and replace with new.
  - b. Weld gate latches and hinges to posts as indicated for new fencing.

- B. Painting: Disassemble existing fence and all attachment hardware (bands, pipe, and wire) prior to preparation of posts for painting. Replace attachment hardware with new.
1. Preparation: Prepare exposed steel posts, rails and accessories thoroughly cleaned of rust, oil and foreign materials. Painted galvanized metal shall be stripped to bare metal before applying prime coat.
  2. Priming: Spot prime areas from which the original surface coating had been removed with a metal primer to match adjoining surfaces. Subsequently, install a prime coat to the entire surface to be painted.
  3. First Coat: Install first coat as recommended by the paint manufacturer. Furnish a color that is 10 percent to 15 percent lighter or darker than the finish coat.
  4. Second or Finish Coat: Install finish coat after the first coat has cured.
  5. Install paint in accordance with manufacturer's written recommendations.
  6. Protect adjacent structures, walls, concrete or asphalt from paint.

### 3.06 INSTALLATION OF GATES

- A. Provide gates of the sizes indicated on Drawings. Allow clearance on gates of 1-1/2 inches at bottom and one inch at top. Construct gates installed in sloping areas to conform to the grade. Provide an opening in each gate for access to locking device or padlock. Knuckle ends of fabric cut for opening to eliminate hazards.
- B. Sliding Gates and Swing Gates: Fabricate and install as indicated on Drawings. Wheel housing shall be designed to fit tightly to roll track and prevent gate from rolling over objects. Unsupported cantilever type roll gates are not acceptable. Install gate stops in accordance with the drawings. Both top and track stops are required.

### 3.07 COMPLETION

- A. Completed fencing shall form continuous units between points indicated with required parts, accessories, and fittings provided and installed. Clean exposed metal surfaces of cement, grout and other foreign substances.
- B. Fill in holes left by removal of existing fence footings, except in areas where grading Work is indicated or specified, to existing grade with clean earth thoroughly compacted to at least same density as adjoining soil.

### 3.08 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

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3.09            CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION