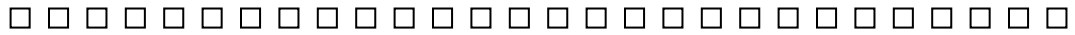


Project Manual



HVAC & Reroof at Mullen Gymnasium at Taft Union High School

for:

Taft Union High School District

Project #

2020-2054
File# 15-H5
A#03 -123655

Set #

TAFT UNION HIGH SCHOOL DISTRICT

HVAC & Re-roof @ Mullen Gymnasium – Taft High School
701 WILDCAT WAY, TAFT CA 93268

DISTRICT

Taft Union High School District
701 Wildcat Way
Taft, CA 93268

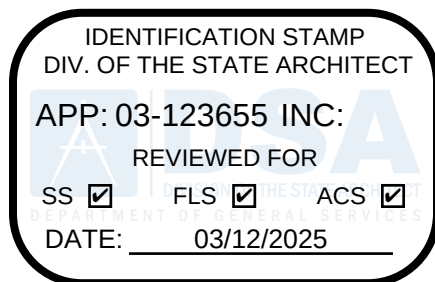
DIVISION OF THE STATE ARCHITECT

Department of General Services
State of California

PROJECT DOCUMENTS PREPARED BY:

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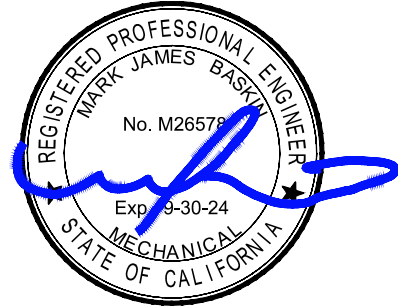
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IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT

APP: 03-123655 INC:

REVIEWED FOR

SS ☒ FLS ☒ ACS ☒

DATE: 03/12/2025

INDEX OF DOCUMENTS

DIVISION 00	<u>BIDDING & CONTRACT REQUIREMENTS</u>
	• 01 Notice to Contractors Calling for Bids
	• 02 Instruction to Bidders
	➤ 03 Bid Form
	➤ 04 Substitution Listing (Not Used)
	➤ 05 List of Subcontractors
	➤ 06 Bid Bond
	➤ 07 Non-Collusion Declaration
	➤ 08 Exclusion of Lead and Asbestos Products (Not Used)
	• 09 Construction Agreement
	• 10 General Conditions
	• 11 Supplemental General Conditions (Not Used)
	• 12 Payment Bond
	• 13 Performance Bond
	• 14 Workers Compensation Certificate
	• 15 Guarantee
	• 16 Fingerprinting Certification by Contractors
	• 17 Davis Bacon Compliance Certification (Not Used)
	• 18 Escrow Agreement for Security Deposits in lieu of Retention
	• 19 Shop Drawing Transmittal (Not Used)
	• 20 Drug-Free Workplace Certification
	• 21 Change Order Form
	➤ 22 Certificate of Attendance at Mandatory Job Walk
	➤ 23 Contractor's Qualifications Questionnaire (Not Used)
	➤ 24 Attachment Form
	25 AB 1565 Contractor Prequalification Questionnaire (Not Used)
	➤ 26 AB 1565 Prequalification Questionnaire Validation (Not Used)
	➤ 27 Iran Contracting Act Certification
	➤ <i>Symbol indicates items that must be submitted with Bid at time of Bid opening.</i>
DIVISION 01	<u>GENERAL REQUIREMENTS</u>
01 11 00	Summary of Work
01 30 00	Administrative Requirements
01 40 00	Quality Requirements
01 41 00	Regulatory Requirements
01 42 16	Definitions
01 42 19	Reference Standards
01 45 23	Tests and Inspections
01 50 00	Temporary Facilities and Controls
01 60 00	Product Requirements
01 70 00	Execution and Closeout Requirements
01 74 00	Construction Waste Management and Disposal
DIVISION 02	<u>EXISTING CONDITIONS</u>
02 41 19	Selective Building Demolition

INDEX OF DOCUMENTS

DIVISION 03	<u>CONCRETE</u>
03 10 00	Concrete Formwork & Accessories
03 20 00	Concrete Reinforcement
03 30 00	Cast in Place Concrete
DIVISION 04	<u>MASONRY</u>
	Not Used
DIVISION 05	<u>METALS</u>
05 41 00	Structural Metal Stud Framing
05 50 00	Metal Fabrications
05 51 33	Metal Ladders
DIVISION 06	<u>WOOD, PLASTICS AND COMPOSITES</u>
	Not Used
DIVISION 07	<u>THERMAL AND MOISTURE PROTECTION</u>
07 54 16	Polyvinyl-Chloride (PVC) Roofing
07 62 00	Sheet Metal Flashing and Trim
07 72 00	Roof Accessories
07 92 00	Joint Sealants
DIVISION 08	<u>OPENINGS</u>
08 31 13	Access Doors and Frames
08 41 13	Storefront and Entrance Doors
08 45 23	Insulated Translucent Panel System
08 71 00	Door Hardware
08 81 00	Glass and Glazing
DIVISION 09	<u>FINISHES</u>
09 21 16	Gypsum Board Assemblies
09 51 00	Acoustical Ceilings
09 91 13	Exterior Painting
DIVISION 10	<u>SPECIALTIES</u>
10 14 00	Signage
10 14 56	Site Signage
DIVISION 11	<u>EQUIPMENT</u>
	Not Used
DIVISION 12	<u>FURNISHINGS</u>
	Not Used
DIVISION 13	<u>SPECIAL CONSTRUCTION</u>
	Not Used
DIVISION 14	<u>CONVEYING EQUIPMENT</u>
	Not Used
DIVISION 21	<u>FIRE SUPPRESSION</u>
	Not Used
DIVISION 22	<u>PLUMBING</u>

INDEX OF DOCUMENTS

	22 00 00	Plumbing
DIVISION 23		<u>HEATING, VENTILATING AND AIR-CONDITIONING</u>
	23 00 00	Heating, Ventilating & Air Conditioning
DIVISION 25		<u>INTEGRATED AUTOMATION</u>
	25 01 11	EMCS Start-Up Verification and Commissioning
	25 01 12	EMCS Training
	25 05 01	General Requirements
	25 05 02	EMCS Submittals and Review Process
	25 05 03	EMCS Project Record Documents
	25 10 01	EMCS Networks
	25 10 02	EMCS Computer Systems, MMI
	25 30 01	EMCS Field Controllers
	25 35 13	EMCS Actuators and Operators
	25 35 16	EMCS Sensors and Transmitters
	25 35 19	EMCS Control Valves
	25 35 23	EMCS Control Dampers
	25 35 27	EMCS Variable Frequency Drives
	25 90 01	EMCS Site Requirement Applications & Sequences of Operations
DIVISION 26		<u>ELECTRICAL</u>
	26 00 00	Electrical
DIVISION 27		<u>COMMUNICATIONS</u>
		Not Used
DIVISION 31		<u>EARTHWORK</u>
	31 22 00	Earthwork
DIVISION 32		<u>EXTERIOR IMPROVEMENTS</u>
	32 12 16	Asphaltic Concrete Paving
	32 13 00	Site Concrete Paving
	32 17 00	Paving Accessories and Striping
	32 17 26	Tactile Warning Surfacing
	32 31 13	Chain Link Fences and Gates
	32 80 00	Irrigation
	32 93 00	Trees, Plants, and Ground Cover
DIVISION 33		<u>UTILITIES</u>
		Not Used

END OF INDEX

SUMMARY OF WORK

SECTION 01 11 00

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Work by Owner;
 - 3. Owner Furnished Products;
 - 4. Future Work;
 - 5. Owner Occupancy;
 - 6. Base Bid Scope of Work.

1.02 WORK BY OWNER

- A. Items noted "NIC" (Not in Contract) including, but not limited, to moveable cabinets, furnishings, minor equipment, etc. will be furnished and installed by Owner.

1.03 OWNER FURNISHED PRODUCTS

- A. Owner's Responsibilities:
 - 1. Arrange for and deliver Owner-reviewed shop drawings, product data and samples to Contractor.
 - 2. Arrange and pay for product delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
 - 4. Submit claims for transportation damage and replace damaged, defective or deficient items.
 - 5. Arrange for manufacturer's warranties, inspections and service.
- B. Contractor's Responsibilities:
 - 1. Review Owner-reviewed shop drawings, product data and samples.
 - 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.
 - 5. Cooperate with Owner to minimize conflict with Owner's rights to occupy substantially completed building(s).

1.04 FUTURE WORK

- A. Refer to Architectural Site Plan Sheet for areas designated for completion in the future.
 - 1. Contract work installed for future facilities shall be tagged and a description provided to the Owner of locations for future connection.

SUMMARY OF WORK

SECTION 01 11 00

1.05 OWNER OCCUPANCY

A. Partial Occupancy:

1. Owner reserves the right to occupy, place and install equipment as necessary in substantially completed buildings. Cooperate with Owner to minimize conflict and facilitate Owner's operations.

B. Acceptance of Work:

1. Partial occupancy does not constitute acceptance of work. Refer to **General Conditions, Article 53 – Contract Closeout and Article 54 – Completion**

1.06 BASE BID SCOPE OF WORK

- ##### A. The "Project", of which the "Work" of this contract is a part, is titled "HVAC and Reroof at Mullen Gymnasium at Taft High School".

- ##### B. The "Work" of this contract is defined by the Contract Documents and is defined to include all site improvements, utilities and construction: to remove the existing HVAC system and replace it with a new one, remove the existing roof and replace with a new single-ply membrane system, to remove the existing, exterior windows and replace with new ones and modify the existing electrical system to accommodate the new HVAC devices.

1. This section describes the scope of work of the BASE BID for this project.
 - a. Refer to the description of individual bid packages in the Construction Manager's Manual for specific scope of work included in each specific bid package.

C. BASE BID

1. ARCHITECTURAL

- a. Based bid shall include extent of work as shown on Attachments *(list attachments)*.

2. STRUCTURAL

- a. Based bid shall include extent of work as shown on Attachments *(list attachments)*.

3. MECHANICAL

- a. Based bid shall include extent of work as shown on Attachments *(list attachments)*.

4. ELECTRICAL

- a. Based bid shall include extent of work as shown on Attachments *(list attachments)*.

**SUMMARY OF WORK
SECTION 01 11 00**

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 11 00

ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. General administrative requirements;
 - 3. Electronic document submittal service;
 - 4. Preconstruction meeting;
 - 5. Site mobilization meeting;
 - 6. Progress meetings.
 - 7. Construction progress schedule.
 - 8. Contractor's daily reports.
 - 9. Coordination drawings.
 - 10. Submittals for review, information, and project closeout.
 - 11. Number of copies of submittals.
 - 12. Requests for Interpretation (RFI) procedures.
 - 13. Submittal procedures.
- B. Related Sections:
 - 1. Section 01 60 00: Product Requirements
 - a. General product requirements.
 - 2. Section 01 70 00: Execution and Closeout Requirements
 - a. Additional coordination requirements.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Conform to requirements of Section 01 70 0 "Execution and Closeout Requirements" for coordination of execution of administrative tasks with timing of construction activities.
- B. Make the following types of submittals to Architect:
 - 1. Requests for Interpretation (RFI).
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Design data.
 - 6. Manufacturer's instructions and field reports.
 - 7. Applications for payment and change order requests.
 - 8. Progress schedules.
 - 9. Coordination drawings.

**ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00**

10. Correction Punch List and Final Correction Punch List for Notice of Completion.
11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

2.01 ELECTRONIC DOCUMENT SUBMITTAL PROCESS

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an email system.
 1. Besides submittals for review, interpretation and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 2. Contractor and Architect are required to use this process.
 3. It is Contractor's responsibility to submit documents in allowable format.
 4. Subcontractors, suppliers, and Architect's consultants are to be permitted to use the service at no extra charge.
 5. Users of the process need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
 6. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.
- B. Project Closeout: Architect will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

2.02 PRECONSTRUCTION MEETING

- A. Attendance Required:
 1. Owner
 2. Architect
 3. Contractor
- B. Agenda:
 1. Execution of Owner-Contractor Agreement.
 2. Submission of executed bonds and insurance certificates.
 3. Distribution of Contract Documents.
 4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.

ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00

5. Designation of personnel representing the parties to Contract, Contractor and Architect.
 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
- C. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

2.03 SITE MOBILIZATION MEETING

- A. Architect will schedule meeting at the Project site prior to Contractor occupancy.
- B. Attendance Required:
1. Owner.
 2. Contractor.
 3. Architect.
 4. Contractor's superintendent.
 5. Major subcontractors.
- C. Agenda:
1. Use of premises by Owner and Contractor.
 2. Owner's requirements and occupancy prior to completion.
 3. Construction facilities and controls provided by Owner.
 4. Temporary utilities provided by Owner.
 5. Survey and building layout.
 6. Security and housekeeping procedures.
 7. Schedules.
 8. Application for payment procedures.
 9. Procedures for testing.
 10. Procedures for maintaining record documents.
 11. Requirements for start-up of equipment.
 12. Inspection and acceptance of equipment put into service during construction period.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

2.04 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.

ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00

- B. Make arrangements for meetings, prepare agenda with copies for participants and preside at meetings.
- C. Attendance Required:
 - 1. Contractor's project manager.
 - 2. Owner.
 - 3. Architect.
 - 4. Contractor's superintendent.
 - 5. Major subcontractors.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede, or will impede, planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Maintenance of progress schedule.
 - 7. Corrective measures to regain projected schedules.
 - 8. Planned progress during succeeding work period.
 - 9. Maintenance of quality and work standards.
 - 10. Effect of proposed changes on progress schedule and coordination.
 - 11. Other business relating to work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

2.05 CONSTRUCTION PROGRESS SCHEDULE

- A. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- B. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
 - 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
- C. Within 10 days after joint review, submit complete schedule.
- D. Submit updated schedule with each Application for Payment.

2.06 DAILY CONSTRUCTION REPORTS

- A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.

ADMINISTRATIVE REQUIREMENTS

SECTION 01 30 00

- B. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
 - 1. Date.
 - 2. High and low temperatures and general weather conditions.
 - 3. List of subcontractors at Project site.
 - 4. List of separate contractors at Project site.
 - 5. Material deliveries.
 - 6. Safety, environmental or industrial relations incidents.
 - 7. Meetings and significant decisions.
 - 8. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
 - 9. Testing and/or inspections performed.
 - 10. List of verbal instruction given by Owner and/or Architect.
 - 11. Signature of Contractor's authorized representative.

2.07 COORDINATION DRAWINGS

- A. Provide information required by Project Coordinator for preparation of coordination drawings.
- B. Update record drawings on a monthly basis as required as a release for progress payments.
- C. Review drawings prior to submission to Architect.

2.08 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking one of the following:
 - 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in the Contract Documents.
 - 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of the Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 - 1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do not forward requests which solely require internal coordination between subcontractors.

ADMINISTRATIVE REQUIREMENTS

SECTION 01 30 00

2. Prepare in a format and with content acceptable to Owner.
 3. Prepare using an electronic version of the form appended to this section.
 4. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
- C. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
1. Include in each request Contractor's signature attesting to good faith effort to determine from the Contract Documents information requiring interpretation.
 2. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this section).
 - b. Approval of substitutions (see Section - 01 60 00 "Product Requirements")
 3. Improper RFIs: Requests not prepared in conformance to requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, the Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
- D. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 2. Owner's, Architect's, and Contractor's names.
 3. Discrete and consecutive RFI number and descriptive subject/title.
 4. Issue date, and requested reply date.
 5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
 6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
 7. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- E. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

ADMINISTRATIVE REQUIREMENTS

SECTION 01 30 00

- F. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
 - 1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 - 2. Note dates of when each request is made, and when a response is received.
 - 3. Highlight items requiring priority or expedited response.
 - 4. Highlight items for which a timely response has not been received to date.
 - 5. Identify and include improper or frivolous RFIs.
- G. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 3:00 PM will be considered as having been received on the following regular working day.
 - 1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- H. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
 - 1. Response may include a request for additional interpretation, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 - 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
 - 3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
 - 4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

2.09 SUBMITTAL SCHEDULE

- A. Submit to Architect for review a schedule for submittals in tabular format.
 - 1. Submit at the same time as the preliminary schedule.
 - 2. Coordinate with Contractor's construction schedule and schedule of values.
 - 3. Format schedule to allow tracking of status of submittals throughout duration of construction.
 - 4. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 - 5. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.

ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00

2.10 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Samples for selection.
 - 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 70 00 "Execution and Closeout Requirements".

2.11 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Certificates.
 - 3. Test reports.
 - 4. Inspection reports.
 - 5. Manufacturer's instructions.
 - 6. Manufacturer's field reports.
 - 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner.

2.12 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List.
- B. Submit Final Correction Punch List for Notice of Completion/Owner occupancy.
- C. When the following items are specified in individual sections, submit them at project closeout in conformance with this section and the General Conditions, Article 54 "Final Inspection and Contract Closeout":
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.

ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00

- D. Submit for Owner's benefit during and after project completion.

2.13 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
1. After review, produce duplicates.
 2. Retained samples will not be returned to Contractor unless specifically so stated.

2.14 SUBMITTAL PROCEDURES

- A. General Requirements:
1. Use a separate transmittal for each item.
 2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
 3. Transmit using approved form.
 - a. Use form included at the end of this Section.
 4. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
 5. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
 6. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
 7. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
 - a. Upload submittals in electronic form to Electronic Document Submittal process.
 8. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 21 calendar days excluding delivery time to and from the Contractor.
 - b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
 9. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 10. Provide space for Contractor and Architect review stamps.

ADMINISTRATIVE REQUIREMENTS

SECTION 01 30 00

11. When revised for resubmission, identify all changes made since previous submission.
12. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
13. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
14. Submittals not requested will be recognized, and will be returned "Not Reviewed".

B. Product Data Procedures:

1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal.
4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:

1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting the Contract Documents and coordinating related work.
2. Do not reproduce the Contract Documents to create shop drawings.
3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:

1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.15 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.
- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
- D. Architect's and his consultants' actions on items submitted for review:
 1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Reviewed" or language with same legal meaning.
 - b. "Reviewed and Corrected" resubmission not required, or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.

ADMINISTRATIVE REQUIREMENTS
SECTION 01 30 00

2. Not-Authorizing fabrication, delivery, and installation.
 - a. "Revise and Resubmit", or language with same legal meaning.
 - b. "Not Acceptable" or language with same legal meaning.
- E. Architect's and his consultants' actions on items submitted for information:
 1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
 2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 01 30 00

**QUALITY REQUIREMENTS
SECTION 01 40 00**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Submittals.
 - 2. Quality assurance.
 - 3. References and standards.
 - 4. Testing and inspection agencies and services.
 - 5. Control of installation.
 - 6. Tolerances
 - 7. Defect Assessment.
- B. Related Sections:
 - 1. Section 01 30 00: Administrative Requirements
 - a. Submittal procedures.
 - 2. Section 01 42 16: Definitions.
 - 3. Section 01 42 19: Reference Standards.
 - 4. Section 01 60 00: Product Requirements
 - a. Requirements for material and product quality.

1.02 REFERENCE STANDARDS

- A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants; 2008 (Reapproved 2014).
- B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation; 2016.
- C. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2012a.
- D. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2014a.
- E. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2015.
- F. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2010.

**QUALITY REQUIREMENTS
SECTION 01 40 00**

1.03 SUBMITTALS

- A. See Section 01 30 00 "Administrative Requirements" for submittal procedures.
- B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.
- C. Test Reports: After each test/inspection, promptly submit two copies of report to Architect, Contractor, DSA and inspector.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test/inspection.
 - h. Date of test/inspection.
 - i. Results of test/inspection.
 - j. Conformance with Contract Documents.
 - k. When requested by Architect, provide interpretation of results.
- D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
 - 1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product but must be acceptable to Architect.
- E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- F. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.
 - 2. Data indicating inappropriate or unacceptable Work may be subject to action by Architect or Owner.

**QUALITY REQUIREMENTS
SECTION 01 40 00**

1.04 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Obtain copies of standards where required by product specification sections.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until the Notice of Completion.
- E. Should specified reference standards conflict with Contract Documents, the Contractor shall request clarification from Architect before proceeding.
- F. Neither the contractual relationships, duties nor responsibilities of the parties in the Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.05 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. Owner will employ and pay for services of an independent testing agency to perform other specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step-in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, the Contractor shall request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

QUALITY REQUIREMENTS
SECTION 01 40 00

- E. Work shall be performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, the Contractor shall request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

3.03 TESTING AND INSPECTION

- A. Testing Agency Duties:
 - 1. Test samples of mixes submitted by Contractor.
 - 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified standards.
 - 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 5. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
 - 6. Perform additional tests and inspections required by Architect.
 - 7. Attend preconstruction meetings and progress meetings.
 - 8. Submit reports of all tests/inspections specified.
- B. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- C. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.

QUALITY REQUIREMENTS
SECTION 01 40 00

2. Cooperate with laboratory personnel and provide access to the Work and to manufacturers' facilities.
 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- D. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
- E. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.04 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not conforming to specified requirements.

END OF SECTION 01 40 00

REGULATORY REQUIREMENTS
SECTION 01 41 00

PART 1 GENERAL

1.01 GOVERNING AGENCY

- A. The governing agencies having review over this project are as follows:
1. Division of the State Architect (DSA):
 - a. Structural Safety Section
 - b. Fire and Life Safety Section
 - c. Access Compliance Section

1.02 LAWS AND REGULATIONS

- A. The project shall be constructed under the jurisdiction of all laws of the State of California governing the construction of public buildings including:
1. California Code of Regulations, Title 8.
 2. California Code of Regulations, Title 19, Public Safety, State Fire Marshal Regulations.
 3. California Code of Regulations, Title 24:
 - a. 2019 California Building Standards Administrative Code (Part 1);
 - b. 2019 California Building Code Volumes 1 and 2 (Part 2);
 - c. 2019 California Electrical Code (Part 3);
 - d. 2019 California Mechanical Code (Part 4);
 - e. 2019 California Plumbing Code (Part 5);
 - f. 2019 California Energy Code (Part 6);
 - g. 2019 California Fire Code (Part 9);
 - h. 2019 Existing Building Code (Part 10);
 - i. 2019 California Green Building Standards Code (Part 11);
 - j. 2019 California Referenced Standards Code, Title 24 C.C.R. (Part 12)
 4. 2016 NFPA 13, Installation of Fire Sprinkler Systems, California amended
 5. 2016 NFPA 14, Installation of Standpipe and Hose Systems
 6. 2017 NFPA 17, Dry Chemical Extinguishing Systems
 7. 2017 NFPA 17A, Wet Chemical Extinguishing Systems
 8. 2016 NFPA 20, Installation of Stationary Pumps for Fire Protection
 9. 2013 NFPA 22, Water Tanks for Private Fire Protection
 10. 2016 NFPA 24, Installation of Private Fire Service Mains
 11. 2017 NFPA 25, Inspection, Testing, Maintenance of Water-Based Fire Protection Systems, California amended
 12. 2016 NFPA 72, National Fire Alarm Code, California amended.
See UL Std. 1971 for "Visual Devices."
 13. 2016 NFPA 80 Fire Door and Other Opening Protectives.
 14. 2015 NFPA 253 Critical Radiant Flux of Floor Covering Systems.
 15. 2015 NFPA 2001 Clean Agent for Fire Extinguishing Systems.
 16. Occupational Health and Safety Act.
 17. Interpretive Manuals, Code Rules, and Safety Orders of:
 - a. State Fire Marshal.

**REGULATORY REQUIREMENTS
SECTION 01 41 00**

- b. Division of the State Architect.
 - c. Division of Industrial Safety.
 - d. Department of Industrial Relations.
 - e. Other Agencies.
18. San Joaquin Valley Air Quality Management District
- B. Nothing in the plans or specifications is to be construed to permit work not in conformance with any applicable code or regulation.
- C. Other Regulatory Requirements and General Conditions:
- 1. T-24, Parts 1-5 must be kept on site during construction.
 - 2. If any conflicts or inconsistencies exist between the specifications and the drawings (including the General Notes), the drawings and General Notes shall take precedence.
 - 3. All Addenda must be signed by the Architect and approved by the Division of the State Architect (2016 CBC Part 1, Section 4-338(b)).
 - 4. All substitutions affecting DSA regulated items shall be considered as a Construction Change Document (CCD) or Addenda and shall be approved by DSA prior to fabrication and installation. (DSA IR A-6 and CBC 2016 Part 1, Section 4-338(c)).
 - 5. The Construction Change Documents must be signed by the owner and approved by the following:
 - a. Architect/Engineer of Record
 - b. Structural Engineer (when applicable)
 - c. Delegated professional engineer (when applicable)
 - d. DSA
 - 6. The Project Inspector (2019 CBC Part 1, Section 4-333(b)) and testing lab (2019 CBC Part 1, Section 4-335.1) must be employed by the owner and approved by the following:
 - a. Architect/Engineer of Record
 - b. Structural Engineer (when applicable)
 - c. DSA

PART 2 PRODUCTS NOT USED

PART 3 EXECUTION NOT USED

END OF SECTION 01 41 00

DEFINITIONS
SECTION 01 42 16

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
1. This section supplements the definitions contained in the General Conditions.
 2. Other definitions are included in individual specification sections.

1.02 DEFINITIONS

- A. Furnish: To supply, deliver, unload, and inspect for damage.
- B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.
- C. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never used, or re-used materials or equipment.
- D. Project Manual: The book-sized volume that includes the procurement requirements (if any), the contracting requirements, and the specifications.
- E. Provide: To furnish and install.
- F. Supply: Same as Furnish.

PART 2 PRODUCTS NOT USED

PART 3 EXECUTION NOT USED

END OF SECTION 01 42 16

**REFERENCE STANDARDS
SECTION 01 42 19**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Requirements relating to referenced standards.
 - 2. Reference standards full title and edition date.

1.02 QUALITY ASSURANCE

- A. For products or workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard of date of issue specified in this section, except where a specific date is established by applicable code.
- C. Obtain copies of standards when required by the Contract Documents.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Date of Notice of Completion.
- E. Should specified reference standards conflict with Contract Documents, the Contractor shall request clarification from the Architect before proceeding.
- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Architect shall be altered by the Contract Documents by mention or inference otherwise in any reference document.

1.03 CONSTRUCTION INDUSTRY ORGANIZATION DOCUMENTS

- A. AAMA -- AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION
 - 1. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for windows, doors, and skylights; 2011.
 - 2. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2014 (2015 Errata).
 - 3. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
 - 4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2013.
 - 5. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.

REFERENCE STANDARDS
SECTION 01 42 19

B. ACI -- AMERICAN CONCRETE INSTITUTE INTERNATIONAL

1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
3. ACI 301 - Specifications for Structural Concrete; 2016.
4. ACI 302.1R - Guide for Concrete Floor and Slab Construction; 2004 (Errata 2007).
5. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
6. ACI 305R - Guide to Hot Weather Concreting; 2010.
7. ACI 306R - Cold Weather Concreting; 2010.
8. ACI 308R - Guide to Curing Concrete; 2001 (Reapproved 2008).
9. ACI 347R - Guide to Formwork for Concrete; 2014.

C. AISC -- AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.

1. AISC S303 - Code of Standard Practice for Steel Buildings and Bridges; 2016.

D. ANSI -- AMERICAN NATIONAL STANDARDS INSTITUTE

1. ANSI A108/A118/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2017.
2. ANSI A135.4 - American National Standard for Basic Hardboard; 2012.
3. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2013.1.
4. ANSI A208.1 - American National Standard for Particleboard; 2009.
5. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015.

E. ASTM INTERNATIONAL

1. ASTM A1 - Standard Specification for Carbon Steel Tee Rails; 2000 (Reapproved 2010).
2. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
3. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2003
4. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
5. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2013.
6. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
7. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
8. ASTM A242/A242M - Standard Specification for High-Strength Low-Alloy Structural Steel; 2013.
9. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2013.
10. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2014.

REFERENCE STANDARDS
SECTION 01 42 19

11. ASTM A424/A424M - Standard Specification for Steel, Sheet, for Porcelain Enameling; 2009a (Reapproved 2016).
12. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use; 2014.
13. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
14. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2014.
15. ASTM A514/A514M - Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding; 2014.
16. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality; 2014.
17. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2015.
18. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts (Metric); 2007 (Reapproved 2013).
19. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2015.
20. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance; 2015.
21. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2016.
22. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
23. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
24. ASTM A759 - Standard Specification for Carbon Steel Crane Rails; 2010 (Reapproved 2016).
25. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement; 2014.
26. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2011 (Reapproved 2015).
27. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2016.
28. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2015.
29. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2017.
30. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
31. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2016.

REFERENCE STANDARDS
SECTION 01 42 19

32. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
33. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2013.
34. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
35. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2016.
36. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2016b.
37. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2016a.
38. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2016a.
39. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2015a.
40. ASTM C150/C150M - Standard Specification for Portland Cement; 2016.
41. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2016.
42. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
43. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products; 2016e1.
44. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2015.
45. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2016.
46. ASTM C501 - Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser; 1984 (Reapproved 2015).
47. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2014).
48. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.
49. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2013a.
50. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2013.
51. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2014.
52. ASTM C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants; 2015a.
53. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2016.
54. ASTM C834 - Standard Specification for Latex Sealants; 2014.

REFERENCE STANDARDS

SECTION 01 42 19

55. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2017.
56. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2015).
57. ASTM C903 - Standard Practice for Preparing Refractory Specimens by Cold Gunning; 2015.
58. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014a.
59. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2016.
60. ASTM C1036 - Standard Specification for Flat Glass; 2016.
61. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.
62. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2013.
63. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2016.
64. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2014a.
65. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.
66. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2008 (Reapproved 2012).
67. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing; 2013a.
68. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2014.
69. ASTM C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus; 2011.
70. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2015.
71. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2014a.
72. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2013.
73. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2016.
74. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2009.
75. ASTM D523 - Standard Test Method for Specular Gloss; 2014.
76. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2014.
77. ASTM D570 - Standard Test Method for Water Absorption of Plastics; 1998 (Reapproved 2010).
78. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2014.
79. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics; 2015.
80. ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints; 2002 (Reapproved 2009).

REFERENCE STANDARDS
SECTION 01 42 19

81. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2016.
82. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings; 2013.
83. ASTM D994/D994M - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type); 2011 (Reapproved 2016).
84. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments; 2008.
85. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types); 2004 (Reapproved 2013).
86. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2013).
87. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine; 2011.
88. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting; 2015.
89. ASTM D2178/D2178M - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing; 2015a.
90. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015.
91. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2016.
92. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) ; 1993 (Reapproved 2010).
93. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016.
94. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2016.
95. ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test; 2009.
96. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2015.
97. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2012).
98. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
99. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
100. ASTM E94 - Standard Guide for Radiographic Examination; 2004 (Reapproved 2010).

REFERENCE STANDARDS

SECTION 01 42 19

101. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
102. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings; 2011.
103. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2016a.
104. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2013).
105. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments; 2013.
106. ASTM E165/E165M - Standard Test Method for Liquid Penetrant Examination for General Industry; 2012.
107. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
108. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2016).
109. ASTM E413 - Classification for Rating Sound Insulation; 2016.
110. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2016.
111. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2015.
112. ASTM E709 - Standard Guide for Magnetic Particle Testing; 2015.
113. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015.
114. ASTM E1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 2014.
115. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.
116. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.
117. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005 (Reapproved 2012).
118. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2011.
119. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference; 1995 (Reapproved 2011).
120. ASTM E1680 - Standard Test Method for Rate of Air Leakage Through

REFERENCE STANDARDS

SECTION 01 42 19

Exterior Metal Roof Panel Systems; 2011.

121. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2011.
122. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes; 2014a.
123. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.
124. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions; 2016.
125. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
126. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2013.
127. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2014).
128. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2015.
129. ASTM F1861 - Standard Specification for Resilient Wall Base; 2008 (Reapproved 2012).
130. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2016.
131. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; 2015a.
132. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2013.

F. AWS -- AMERICAN WELDING SOCIETY

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2012.
2. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015 (with March 2016 Errata).
3. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2008.

G. BHMA -- BUILDERS HARDWARE MANUFACTURERS ASSOCIATION

1. BHMA A156.9 - American National Standard for Cabinet Hardware; 2015.

H. CDA -- COPPER DEVELOPMENT ASSOCIATION, INC.

1. CDA A4050 - Copper in Architecture - Handbook; current edition.

I. CRI -- CARPET AND RUG INSTITUTE

1. CRI 104 - Standard for Installation of Commercial Carpet; 2015.
2. CRI (GLP) - Green Label Plus Testing Program - Certified Products; www.carpet-rug.org; current edition.

REFERENCE STANDARDS
SECTION 01 42 19

- J. FM -- FACTORY MUTUAL GLOBAL
 - 1. FM (AG) - FM Approval Guide; current edition.
- K. GA -- GYPSUM ASSOCIATION
 - 1. GA-216 - Application and Finishing of Gypsum Board; 2016.
- L. GANA -- GLASS ASSOCIATION OF NORTH AMERICA
 - 1. GANA (GM) - GANA Glazing Manual; 2009.
 - 2. GANA (SM) - GANA Sealant Manual; 2008.
- M. IAS -- INTERNATIONAL ACCREDITATION SERVICE
 - 1. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc; 2017.
- N. IGMA -- INSULATING GLASS MANUFACTURERS ALLIANCE
 - 1. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (2004).
- O. ITS -- INTERTEK TESTING SERVICES NA, INC.
 - 1. ITS (DIR) - Directory of Listed Products; current edition.
- P. MPI -- MASTER PAINTERS INSTITUTE (MASTER PAINTERS AND DECORATORS ASSOCIATION)
 - 1. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition, www.paintinfo.com.
- Q. NEMA -- NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
 - 1. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- R. NFPA -- NATIONAL FIRE PROTECTION ASSOCIATION
 - 1. NFPA 10 - Standard for Portable Fire Extinguishers; 2013.
 - 2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2012.
 - 3. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2015.
 - 4. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth; 2015.
- S. NFRC -- NATIONAL FENESTRATION RATING COUNCIL, INC.
 - 1. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2014.
 - 2. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2014.
 - 3. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2014.
- T. RCSC -- RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS
 - 1. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections; 2014, with April 2015 Errata.

REFERENCE STANDARDS
SECTION 01 42 19

- U. SMACNA -- SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.
 - 1. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.
- V. SSPC -- SOCIETY FOR PROTECTIVE COATINGS
 - 1. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 1999 (Ed. 2004).
 - 2. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 2002 (Ed. 2004).
 - 3. SSPC-SP 1 - Solvent Cleaning; 2015.
 - 4. SSPC-SP 2 - Hand Tool Cleaning; 1982 (Ed. 2004).
 - 5. SSPC-SP 3 - Power Tool Cleaning; 1982 (Ed. 2004).
 - 6. SSPC-SP 5 - White Metal Blast Cleaning; 2007.
 - 7. SSPC-SP 6 - Commercial Blast Cleaning; 2007.
 - 8. SSPC-SP 7 - Brush-Off Blast Cleaning; 2007.
 - 9. SSPC-SP 10 - Near-White Blast Cleaning; 2007.
 - 10. SSPC-SP 11 - Power Tool Cleaning to Bare Metal; 2012 (Ed. 2013).
 - 11. SSPC-SP 13 - Surface Preparation of Concrete; (Reaffirmed 2015); 2003.
- W. SWRI -- SEALANT, WATERPROOFING AND RESTORATION INSTITUTE
 - 1. SWRI (VAL) - SWR Institute Validated Products Directory; Current Listings at www.swrionline.org.
- X. TCNA -- TILE COUNCIL OF NORTH AMERICA, INC.
 - 1. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2016.
- Y. UL -- UNDERWRITERS LABORATORIES INC.
 - 1. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
 - 2. UL (FRD) - Fire Resistance Directory; current edition.
 - 3. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
 - 4. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
 - 5. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.
- Z. WI -- WOODWORK INSTITUTE
 - 1. WI (CCP) - Certified Compliance Program (CCP); current edition at www.woodworkinstitute.com.
 - 2. WI (MAN) - Manual of Millwork; 2016.

1.04 UNITED STATES GOVERNMENT AND RELATED AGENCIES DOCUMENTS

- A. UNITED STATES CODE
 - 1. Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act; 1947 (Revised 2001).

REFERENCE STANDARDS
SECTION 01 42 19

B. CFR -- CODE OF FEDERAL REGULATIONS

1. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
2. CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
3. CFR 37 - Transportation Services for Individuals with Disabilities (ADA); current edition.

C. ATBCB -- US ARCHITECTURAL AND TRANSPORTATION BARRIERS COMPLIANCE BOARD (THE ACCESS BOARD)

1. ATBCB PROWAG - Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; 2011.

D. PS -- PRODUCT STANDARDS

1. PS 1 - Structural Plywood; 2009.
2. PS 2 - Performance Standard for Wood-Based Structural-Use Panels; 2010.
3. PS 20 - American Softwood Lumber Standard; 2015.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION 01 42 19

TEST AND INSPECTIONS

SECTION 01 45 23

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Tests and inspections of materials;
 - a. Structural Steel:
 - 1) Sampling and testing of required specimens, inspection of structural fabrication, shop welding, and field welding as required.
 - b. Wood:
 - 1) Lumber:
 - a) Materials shall be per 2019 California Building Code, Section 2303.

1.02 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Conform to Division of the State Architect (DSA) regulations.
- B. Owner's Inspector:
 - 1. An inspector employed by the Owner in accordance with the requirements of State of California Code of Regulations, Title 24, will be assigned to the work.
 - a. Duties are specifically defined in Title 24, Part I, Section 4-342.
 - b. The work of construction in all stages of progress shall be subject to the personal continuous observation of the inspector.
 - c. They shall have free access to any or all parts of the work at any time.
 - d. The Contractor shall furnish the inspector reasonable facilities for obtaining such information as may be necessary to keep him fully informed respecting the progress and manner of the work and the character of the materials.
 - e. Inspection of the work shall not relieve the Contractor from any obligation to fulfill this Contract.

1.03 SPECIAL PROVISIONS

- A. Laboratory shall be approved by Owner, Architect, Structural Engineer, and Division of the State Architect.
- B. Laboratory shall be in the employ of the Owner.
- C. Duties of Testing Laboratory:
 - 1. Inspect stock, mark identified stock, select and mark test specimens, perform required tests, inspections as specified, furnish required reports and certificates.
- D. Reports:

TEST AND INSPECTIONS

SECTION 01 45 23

1. Reports are to be executed immediately upon conclusion of each procedure and forwarded to:
 - a. Architect;
 - b. Structural Engineer;
 - c. Construction Manager;
 - d. Contractor;
 - e. Owner;
 - f. Subcontractor;
 - g. Project Inspector;
 - h. Division of the State Architect.
2. The Division of the State Architect is the Governing Agency for this project. One copy of all test reports shall be forwarded to that office by the testing agency.
 - a. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory.
 - b. Samples taken, but not tested, shall also be reported.
 - c. Records of special sampling operations as required shall also be reported.
 - d. The reports shall show that the material or materials were sampled and tested in accordance with the requirements of Title 24 and with the approved specifications.
 - e. Test reports shall show the specified design strength.
 - f. They shall also state definitely whether or not the material, or materials, tested comply with requirements.
3. Verification of Test Reports:
 - a. Each testing agency shall submit to the Division of the State Architect a verified report in duplicate covering all of the tests which are required to be made by that agency during the progress of the project.
 - b. Such report shall be furnished each time that work on the project is suspended, covering the tests up to that time, and at the completion of the project, covering all tests.
4. Payment:
 - a. The Owner shall pay for all tests, except costs of concrete mix design.
 - b. When in the opinion of the Architect or the Division of the State Architect, additional tests are required, then such tests and inspection shall be paid for by the Owner, but the amount paid shall be deducted from the Contract Price.
 - c. Examples of such additional tests are:
 - 1) Tests of material substituted for previously accepted materials, unidentified materials, re-tests made necessary by the failure of materials to comply with the requirements of the specifications, and load tests necessary because certain portions of the structure have not fully met specification or plan requirements.
5. Selection of Samples:
 - a. All samples and specimens for testing shall be selected by the inspector or by the testing laboratory, but not by the Contractor.

TEST AND INSPECTIONS

SECTION 01 45 23

- b. The Contractor shall, at his own expense, furnish, package, mark, and deliver all samples to be tested, when so directed by the inspector, testing laboratory, or as required by the specifications.
- c. Delivery of samples to the testing laboratory shall be made in ample time to allow tests to be made without delaying construction.
- d. No extra time will be allowed for the completion of the work by reason of delay in testing samples.
- e. The Contractor shall allow free access at all times to the representatives of the testing laboratory to the sources from which samples are taken.
- 6. Preparation of Specimens:
 - a. Taken by, and at expense of fabricator, under direction of testing laboratory and machined or prepared to conform to appropriate ASTM specification.
 - b. Cost of machining specimens is considered part of the testing.
- 7. Architect and Structural Engineer reserve the right to demand for test and special examination of any materials, or part thereof, to insure compliance with specifications, and may reject for satisfactory replacement, any material, or part judged defective, as a result thereof.
 - a. This also applies to materials or sources of same substituted for those previously approved.
 - b. Such tests or examinations, even though not specified, shall be performed as and when required.
 - c. Costs paid for by Owner, but the amount paid shall be deducted from the Contract;
- 8. Owner's Right to Waive Tests and Inspections:
 - a. The Owner reserves the right to waive any part, or all of the tests and inspections, subject to the approval of the Architect, Structural Engineer, and Division of the State Architect.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SEQUENCING AND SCHEDULING

- A. Coordinate work with that of other trades in time to avoid delays to the overall work progress.
- B. Laboratory shall cooperate with all trades whose work affects or is affected by the tests and inspections.
- C. Contractor to cooperate with and provide testing laboratory opportunity and assistance in taking samples, making field tests, and making inspections.

3.02 TESTS AND INSPECTIONS

- A. All special inspections shall conform to the requirements of 2019 CBC, Part 2, Chapter 17A "Special Inspections and Tests".

TEST AND INSPECTIONS
SECTION 01 45 23

3.03 EARTHWORK (Refer to Section 31 22 00)

- A. Excavations:
 - 1. Chapter 17A:
 - a. Inspections:
 - 1) Earth fill compactions: 1705A.6 and Table 1705A.6
 - 2. Testing Agency:
 - a. Any required foundation consultation, examination, or testing shall be done by an approved Foundation Engineer.
 - b. Costs paid by Owner.
- B. Consultation or Procedures for this part of the work shall be only as requested by the Architect and Structural Engineer at the time work on the site is commenced and may consist of the following:
 - 1. Periodic inspection of any required filling and backfilling, including field density tests if considered necessary.
 - 2. Imported or Native Fill Material: Approved material, perform suitability tests for compaction, qualities, and optimum moisture if required.
 - 3. Provide Continuous Inspection Supervision during removal and re-compaction of existing soil and placement of fill.
 - 4. Field Density Tests shall be made on samples from material in place as required to verify proper compaction densities of fills.
- C. Densities and Method:
 - 1. Densities specified relate to ASTM Designation D1557 Procedure A.

3.04 CONCRETE WORK (Refer to Section 32 13 00)

- A. Inspections:
 - 1. Job Site Inspection: 1705A.3.3
 - 2. Batch Plant or Weighmaster Inspection: 1705A.3.3.
 - 3. Reinforcing Bar Welding Inspection: 1705A.3.1 and 1705A.2.5.
 - 4. Notification:
 - a. The Contractor shall notify the following people, giving advance notice prior to commencing the designated work:
 - 1) Person Notified: Architect and Construction Manager
 - a) Advance Notice: Two Business Days
 - b) Prior to Commencing: Form Work
 - c) For Inspection: Excavation
 - 2) Person Notified: Architect, Construction Manager, and Inspector
 - a) Advance Notice: Two Business Days
 - b) Prior to Commencing: Pouring Concrete
 - c) For Inspection: Forms and Steel
 - 3) Person Notified: Governing Agency
 - a) Advance Notice: Three Business Days
 - b) Prior to Commencing: Pouring Concrete
 - c) For Inspection: Forms and Steel

TEST AND INSPECTIONS

SECTION 01 45 23

5. Bonded Weighmaster Certificates
 - a. Non-structural concrete such as floor slabs on grade, walks, curb & gutter, etc., shall not require continuous batch plant inspection, but instead, a bonded weighmaster shall furnish notarized affidavits certifying that quantities and quality of all materials used in the concrete instead, a bonded weighmaster shall furnish notarized affidavits certifying that quantities and quality of all materials used in the concrete are in accordance with these specifications and the approved mix design.
6. Batch Plant Inspections: When transit mixed concrete is used, continuous inspection shall be maintained at the plant by a qualified concrete technician who shall issue tickets certifying that quantities and quality of all materials used in the concrete are in accordance with these specifications and the approved design mix.
 - a. The Owner will pay the costs of this inspection.
 - b. This inspection will not be required for non-structural concrete as indicated in C.B.C. Section 1705A.3 (exception).
7. No concrete shall be poured except in the presence of the Owner's Inspector and only after the forms and reinforcing steel have been approved by the Architect or his representative.

B. Tests:

1. All concrete materials to be tested and reported prior to any use of same.
2. Cementitious materials shall conform to the requirements of ACI 318, CBC Section 1903A, and ASTM C150.
 - a. One sample shall be taken for each 100 tons of cement, except that when used in bulk loading ready mix plants where separate bins for pre-tested cement are not available, grab samples shall be taken for each shipment of cement placed in the bin with not less than one sample being taken for each day's pour and such samples shall be subsequently tested if required by the Architect, Structural Engineer, or the Division of the State Architect.
3. Aggregate shall be in conformance with ACI 318, as modified by CBC Section 1903A.5.
4. Reinforcing Steel is to be tested prior to use for compliance with CBC Section 1910A.2 and ASTM A615 requirements.
 - a. Samples: To be selected by representative of testing laboratory from material at the building site or place of distribution, to consist of two (2) pieces, each 18 inches (18") long of each size, furnished, cut, and prepared for testing by Contractor, marked and delivered by representative of testing laboratory.
 - b. Tests: One (1) tension and one (1) bend test shall be made of each size of reinforcing steel, including wire fabric. One (1) series of tests shall be made for each ten (10) tons, or fraction thereof, of each size of reinforcing steel if the bundles, as delivered, can be identified as to heat number and the mill analysis accompanies the report. If they cannot be identified as to heat number, then one (1) series of tests shall be made from each two and one-half (2-1/2) tons or fraction thereof.
5. Cylinder Tests shall comply with CBC Section 1905A.1.16.

TEST AND INSPECTIONS

SECTION 01 45 23

- a. Three (3) cylinders of concrete shall be made for each fifty (50) cubic yards of each grade of concrete, or fraction thereof, being placed each day. Each cylinder shall be dated, given a number, the point in the structure from which the sample was taken noted thereon, and the slump noted thereon.
 - b. Test cylinders shall be made at the job and stored in the testing laboratory in accordance with ASTM C31. At the end of twenty-four (24) hours after making, the cylinders shall be stored under moist curing conditions at approximately 70 degrees F. and maintained therein until tested. The cylinders shall be tested in accordance with ASTM C39. The cylinders shall develop the following minimum ultimate compressive strengths:
 - 1) Design Strength: 3000 psi
 - a) 7 Day Test: 1800 psi
 - b) 28 Day Test: 3000 psi
 - 2) Design Strength: 4000 psi
 - a) 7 Day Test: 2300 psi
 - b) 28 Day Test: 4000 psi
 - c. If the strengths of the first two-cylinder tests are satisfactory, the third cylinder shall not be tested, but destroyed. The third cylinder shall be tested if the strengths of the first two cylinders are not satisfactory.
 - d. If the strength of the cylinders does not meet the minimum as mentioned above, core tests of the hardened concrete shall be made as per CBC Section ACI 318, Section 5.5.5.2 and ASTM C42. If the core tests show the concrete strength to be deficient, the concrete shall be deemed defective and removed. The Contractor shall pay all costs of these core tests.
- C. Laboratory Designed Mixes: See Proportioning of Concrete Mixes, Section 03 31 00 "Structural Concrete Work".

TABLE 1

MINIMUM MORTAR AND GROUT STRENGTHS COMPRESSION TESTS

Specimen: Mortar on 2-inch x 4-inch cylinders
At 7 Days: 1100 psi
At 28 Days: 1800 psi
Specimen: Grout in typical prism
At 7 Days: 1200 psi
At 28 Days: 2000 psi

QUICK REFERENCE GUIDE FOR TESTS AND INSPECTIONS (AS APPLICABLE)

TITLE 24, PART 2 (2019 CBC) VOLUME 2 **TESTS AND INSPECTIONS REQUIREMENTS**

TEST AND INSPECTIONS
SECTION 01 45 23

A. STEEL (CHAPTER 22)

1. Materials:
 - a. Cold Formed Steel 2210A.1
 - b. Identification 2203A.1
2. Quality:
 - a. Tests of Structural and Cold Formed Steel 1705A.2.1, Table 1705A.2.1
3. Inspections:
 - a. Welding 1704A.2.5

B. SAFEGUARDS DURING CONSTRUCTION (CHAPTER 33)

END OF SECTION 01 45 23

TEMPORARY FACILITIES AND CONTROLS
SECTION 01 50 00

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Temporary sanitary facilities.
 - 2. Security requirements.
 - 3. Waste removal facilities and services.
 - 4. Project identification sign.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019.
- B. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2019).

1.03 TEMPORARY UTILITIES

- A. Owner will provide the following:
 - 1. Electrical power and metering, consisting of connection to existing facilities.
 - 2. Water supply, consisting of connection to existing facilities.

1.04 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Use of existing facilities is not permitted.
- C. Maintain daily in clean and sanitary condition.
- D. Use of existing facilities is not permitted.

1.05 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.

TEMPORARY FACILITIES AND CONTROLS
SECTION 01 50 00

- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 FENCING

- A. Provide 6-foot-high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.07 SECURITY

- A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.08 VEHICULAR ACCESS AND PARKING

- A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- B. Coordinate access and haul routes with governing authorities and Owner.
- C. Provide and maintain access to fire hydrants, free of obstructions.
- D. Provide means of removing mud from vehicle wheels before entering streets.
- E. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.09 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site periodically.
- C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.10 PROJECT IDENTIFICATION

- A. Provide project identification sign of design and construction indicated on Drawings.
- B. Erect on site at location established by Architect.

TEMPORARY FACILITIES AND CONTROLS
SECTION 01 50 00

- C. No other signs are allowed without Owner permission except those required by law.

1.11 FIELD OFFICES

- A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate six (6) persons.
- C. Provide separate private office similarly equipped and furnished, for use by Owner Project Inspector.
- D. Locate offices a minimum distance of 30 feet from existing and new structures.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities and materials prior to Final Application for Payment inspection.
- B. Remove underground installations to a minimum depth of 2 feet. Contractor shall grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition.
- E. Restore new permanent facilities used during construction to a specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 50 00

**PRODUCT REQUIREMENTS
SECTION 01 60 00**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. General product requirements.
 - 3. Transportation, handling, storage and protection.
 - 4. Product option requirements.
 - 5. Substitution limitations.
 - 6. Maintenance materials, including extra materials, spare parts, tools, and software.
- B. Related Sections:
 - 1. Section 01 40 00: Quality Requirements
 - a. Product quality monitoring.

1.02 REFERENCE STANDARDS

- A. 16 CFR 260.13 - Guides for the Use of Environmental Marketing Claims; Federal Trade Commission; Recycled Content; Current Edition.

1.03 SUBMITTALS

- A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. Submit within 35 days after date of Notice of Contract Award.
- C. For products specified only by reference standards, list applicable reference standards.
- D. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- E. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

**PRODUCT REQUIREMENTS
SECTION 01 60 00**

- F. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Inventory of Product Content: Publicly available inventory of all ingredients identified by name and Chemical Abstract Service Registration Number (CAS RN).
- B. For ingredients considered a trade secret or intellectual property, the name and CAS RN may be omitted, provided the ingredient's role, amount, and GreenScreen Benchmark are given.
- C. Recycled Content: Determine percentage of post-consumer and pre-consumer (post-industrial) content separately, using the guidelines contained in 16 CFR 260.13.
- D. Previously used, reused, refurbished, and salvaged products are not considered recycled.
- E. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
- F. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of all material in the item.
- G. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
- H. Acceptable Evidence:
 - 1. For percentage of recycled content, information from manufacturer.
 - 2. For cost, Contractor's cost data.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. DO NOT USE products having any of the following characteristics:
 - 1. Made using or containing CFC's or HCFC's.
 - 2. Containing lead, cadmium, asbestos.

**PRODUCT REQUIREMENTS
SECTION 01 60 00**

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

PRODUCT REQUIREMENTS
SECTION 01 60 00

3.02 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- G. Comply with manufacturer's warranty conditions, if any.
- H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- I. Prevent contact with material that may cause corrosion, discoloration, or staining.
- J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 60 00

EXECUTION AND CLOSEOUT REQUIREMENTS
SECTION 01 70 00

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Inclusions:

1. Examination, preparation, and general installation procedures.
2. Pre-installation meetings.
3. Cutting and patching.
4. Surveying for laying out the work.
5. Cleaning and protection.
6. Demonstration and instruction of Owner personnel.
7. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
8. General requirements for maintenance service.

B. Related Requirements

1. Section 01 11 00: Summary:
 - a. Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.
2. Section 01 30 00: Administration Requirements
 - a. Submittals procedures, Electronic document submittal service.
3. Section 01 40 00: Quality Requirements
4. Section 01 45 23: Tests and Inspections
 - a. Testing and inspection procedures.
5. Section 01 51 00: Temporary Facilities and Controls
 - a. Temporary exterior enclosures and interior partitions.
6. Section 01 79 00: Demonstration and Training
 - a. Demonstration of products and systems to be commissioned and where indicated in specific specification sections
7. Individual Product Specification Sections:
 - a. Advance notification to other sections of openings required in work of those sections.
 - b. Limitations on cutting structural members.

1.02 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.03 SUBMITTALS

- A. See Section 01 30 00 "Administration Requirements" for submittal procedures.

EXECUTION AND CLOSEOUT REQUIREMENTS
SECTION 01 70 00

- B. Survey work: Submit name, address, and telephone number of Surveyor before starting survey work.
 - 1. On request, submit documentation verifying accuracy of survey work.
 - 2. Submit a copy of site drawing signed by the Land Surveyor, that the elevations and locations of the work are in conformance with Contract Documents.
 - 3. Submit surveys and survey logs for the project record.
- C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - a. Structural integrity of any element of Project.
 - b. Integrity of weather exposed or moisture resistant element.
 - c. Efficiency, maintenance, or safety of any operational element.
 - d. Visual qualities of sight exposed elements.
 - e. Work of Owner or separate Contractor.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.04 QUALIFICATIONS

- A. For survey work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of Surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate.
- B. For field engineering, employ a professional engineer of the discipline required for specific service on Project, licensed in the State in which the Project is located.

1.05 PROJECT CONDITIONS

- A. Use of explosives is not permitted.
- B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- D. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- E. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
 - 1. Provide dust-proof enclosures to prevent entry of dust generated outdoors.
 - 2. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.

EXECUTION AND CLOSEOUT REQUIREMENTS

SECTION 01 70 00

- F. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
 - 1. Minimize amount of bare soil exposed at one time.
 - 2. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
 - 3. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- G. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- H. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- I. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
- J. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.06 COORDINATION

- A. See Section 01 11 00 "Summary of Work" for occupancy-related requirements.
- B. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- C. Notify affected utility companies and comply with their requirements.
- D. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- E. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

EXECUTION AND CLOSEOUT REQUIREMENTS
SECTION 01 70 00

- G. Coordinate completion and clean-up of work of separate sections.
- H. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 "Product Requirements".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or mis-fabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.

EXECUTION AND CLOSEOUT REQUIREMENTS
SECTION 01 70 00

- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Architect four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

- A. Verify locations of survey control points prior to starting work.
- B. Promptly notify Architect of any discrepancies discovered.
- C. Owner will locate and protect survey control and reference points.
- D. Control datum for survey is that indicated on drawings.
- E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- F. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
- H. Utilize recognized engineering survey practices.
- I. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundation, column locations and ground floor elevations.

EXECUTION AND CLOSEOUT REQUIREMENTS

SECTION 01 70 00

- J. Periodically verify layouts by same means.
- K. Maintain a complete and accurate log of control and survey work as it progresses.
- L. On completion of foundation walls and major site improvements, prepare a certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.

3.05 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-conforming work.
- C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

EXECUTION AND CLOSEOUT REQUIREMENTS

SECTION 01 70 00

- E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- F. Restore work with new products in accordance with requirements of Contract Documents.
- G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00 "Firestopping" to full thickness of the penetrated element.
- I. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

EXECUTION AND CLOSEOUT REQUIREMENTS

SECTION 01 70 00

- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.09 DEMONSTRATION AND INSTRUCTION

- A. See Section 01 79 00 "Demonstration and Training".

3.10 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.11 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
 - 1. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.
- B. Use cleaning materials that are nonhazardous.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- F. Clean filters of operating equipment.
- G. Clean debris from roofs, gutters, downspouts, and drainage systems.
- H. Clean site; sweep paved areas, rake clean landscaped surfaces.
- I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

EXECUTION AND CLOSEOUT REQUIREMENTS
SECTION 01 70 00

3.12 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect and Owner.
- B. Accompany Architect and Project Inspector on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's comprehensive list of items to be completed or corrected.
- C. Notify Architect when work is considered ready for Architect's Final Construction Compliance Inspection.
- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Notice of Completion inspection.
- E. Owner will occupy portions of the building as specified in Section 01 11 00 "Summary of Work".
- F. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- G. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- H. Notify Architect when work is considered finally complete and ready for Architect's Construction Compliance final inspection.

3.13 MAINTENANCE

- A. Provide service and maintenance of components indicated in specification sections.
- B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Notice of Completion or the length of the specified warranty, whichever is longer.
- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 01 70 00

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

SECTION 01 74 00

PART 1 GENERAL

1.01 CONSTRUCTION WASTE MANAGEMENT

A. Waste Management Requirements:

1. California Green Building Standards Code (Title 24, Part 11), Section 5.408.1 requires this project recycle and/or salvage for reuse a minimum of 65% of the non-hazardous construction and demolition waste and demolition waste.
2. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination or other factors.
3. Required Recycling, Salvage and Reuse: The following may not be disposed of in landfills or by incineration:
 - a. Aluminum and plastic beverage containers.
 - b. Corrugated cardboard.
 - c. Wood pallets.
 - d. Clean dimensional wood: May be used as blocking or furring.
 - e. Land clearing debris, including brush, branches, logs and stumps.
 - f. Concrete: May be crushed and used as riprap, aggregate, sub-base material or fill if acceptable to the Soils Engineer.
 - g. Bricks: May be used on project if whole, or crushed and used as landscape cover, sub-base material or fill.
 - h. Concrete masonry units: May be used for erosion control or landscape features.
 - i. Precast concrete panels: May be used for erosion control or landscape features.
 - j. Asphalt paving: May be recycled into paving for project.
 - k. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - l. Glass.
 - m. Gypsum drywall and plaster.
 - n. Plastic buckets.
 - o. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (<http://flooring.dupont.com>) and Interface (www.interfaceinc.com) conduct reclamation programs.
 - p. Asphalt roofing shingles.
 - q. Paint.
 - r. Plastic sheeting.

**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
SECTION 01 74 00**

- s. Rigid foam insulation.
 - t. Windows, doors, and door hardware.
 - u. Plumbing fixtures.
 - v. Mechanical and electrical equipment.
 - w. Fluorescent lamps (light bulbs).
 - x. Acoustical ceiling tile and panels.
4. Certification for this project is dependent on diversion of 65 %, by weight, of potential landfill trash/waste by recycling and/or salvage.
SPECIFIER SHALL COORDINATE WITH LOCAL AGENCIES
5. The following recycling incentive programs are mandatory for this project: Contractor is responsible for implementation:
- a. _____: Revenue or savings accrue to Contractor.
 - b. _____: Rebates and credits must be applied for by Owner and shall accrue to Owner.
- SPECIFIER SHALL COORDINATE WITH OWNER*
6. Owner has made arrangements for salvage of the following materials by others:
- a. _____: Recipient will provide containers and pick up.
 - b. _____: Contractor shall deliver to recipient's location at _____ weekly.
7. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
8. The following sources may be useful in developing the Waste Management Plan:
SPECIFIER SHALL COORDINATE WITH LOCAL AGENCIES & OWNER
- a. State Recycling Department, at _____.
 - b. Recycling Haulers and Markets: The attached list contains local haulers and markets for recyclable materials. This list is provided for information only and is not necessarily comprehensive; other haulers and markets are acceptable.
 - c. Recycling Economics Information: The attached list contains information that may be useful in estimating the costs or savings or recycling options.
9. Methods of trash/waste disposal that are not acceptable are:
- a. Burning on the project site.
 - b. Burying on the project site.
 - c. Dumping or burying on other property, public or private.
 - d. Other illegal dumping or burying.
 - e. Incineration, either on- or off-site.
10. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

SECTION 01 74 00

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00 "Summary": List of items to be salvaged from the existing building for relocation in project or for Owner.
- B. Section 01 30 00 "Administrative Requirements": Additional requirements for project meetings, reports, submittal procedures, and project documentation.
- C. Section 01 50 00 "Temporary Facilities and Controls": Additional requirements related to trash/waste collection and removal facilities and services.
- D. Section 01 60 00 "Product Requirements": Waste prevention requirements related to delivery, storage, and handling.
- E. Section 01 70 00 "Execution and Closeout Requirements": Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.
- F. Section 31 10 00 "Site Clearing": Handling and disposal of land clearing debris.

1.03 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris and rubble resulting from construction, remodeling, repair and demolition operations.
- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitability, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitability, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

SECTION 01 74 00

- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

- A. See Section 01 30 00 "Administrative Requirements", for submittal procedures.
- B. Waste Management Plan: Include the following information:
 - 1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
 - 2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s).
 - 3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
 - 4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 - 5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
 - 6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
SECTION 01 74 00**

7. Recycling Incentives: Describe procedures required to obtain credits, rebates, or similar incentives.
8. Recycling Incentive Programs:
 - a. Where revenue accrues to Contractor, submit copies of documentation required to qualify for incentive.
 - b. Where revenue accrues to Owner, submit any additional documentation required by Owner in addition to information provided in periodic Waste Disposal Report.

END OF SECTION 01 74 00

**SELECTIVE BUILDING DEMOLITION
SECTION 02 41 19**

PART 1 GENERAL INFORMATION

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Selective Demolition;
 - a. Extent of demolition work as indicated on Drawings.
 - 3. Site restoration;
 - 4. Disposal of rubbish and debris offsite;
 - 5. Barricades, signs, protective structures, and devices;
 - 6. Clean up.
- B. Related Sections:
 - 1. Section 01 74 19 Construction Waste Management and Disposal

1.02 SUBMITTALS

- A. Record Drawings:
 - 1. Keep a record of the location and size of all capped pipe and/or conduit.
 - 2. Submit record drawings per General Conditions.

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Work shall comply with applicable provisions of local and State safety and health ordinances.
 - a. Prior to start of any demolition, the County of Kern Environmental Health Services Department and Basic Compliance Engineering shall be given 48-hour notice by the Contractor.
 - 2. Take out and maintain required permits, approvals, and licenses necessary to legally complete this work.
 - 3. Insure that subcontractors are properly licensed and have required permits to perform their work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the demolition site to determine the extent of the work included in this Contract.
- B. Accept the premises in the condition as found on the first day of work under this Contract.

**SELECTIVE BUILDING DEMOLITION
SECTION 02 41 19**

3.02 PREPARATION

- A. Notify utility companies concerning cut off or restoration of service or of relocation or modification of any such service that the work of this contract may require.
- B. Protect and maintain in operation utility or sewer lines that are required to remain operative during the period of this contract.

3.03 INSTALLATION OR APPLICATION

- A. Furnish and maintain temporary construction, scaffolding, ladders, runways, hoists, etc.
- B. Maintain a clean and safe work area, and all other affected premises.
- C. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning handling and protection against exposure or environmental pollution.
 - 1. Notify Architect immediately upon encountering hazardous materials.

3.04 PROTECTION OR ADJUSTMENTS

- A. Enclose area of work with fence barricades.
- B. The working area shall be kept securely locked at all times work is in progress.
- C. Post signs and warning devices necessary to exclude all persons, except those directly connected with the work from work areas.
- D. Protect adjacent buildings, shrubs, trees, and lawns from damage.
- E. Do not interfere with use of adjacent buildings, or safe ingress or egress.
- F. Use of explosives will not be permitted.

3.05 CLEANING OR REPAIR

- A. Debris resulting from the work of this Section shall be removed and hauled away from the site.
 - 1. Debris and rubbish shall not be allowed to accumulate on the site.
- B. All material generated by this work shall be disposed of properly outside the project limits in accordance with all applicable regulations, laws, and ordinances.

**SELECTIVE BUILDING DEMOLITION
SECTION 02 41 19**

1. Sprinkle loose material while being stored, handled, or loaded.

C. Burning of removed materials is not permitted within the project limits.

3.06 CONDITIONS OF FINISHED WORK

A. Trees and shrubs where indicated shall be removed along with their roots, stumps, etc.

1. Remove all roots within two feet around edge of stump or shrub.

B. Protections, tools, materials, plant apparatus, and rubbish or debris shall be removed. Sprinkle loose material while being stored, handled, or loaded.

C. Existing areas to remain, public or private property, that may have been damaged, made dirty, or otherwise disorderly as a result of this work shall be restored to good order.

D. Glue residue from removal of floor coverings, wall coverings, tackboard panels, wall accessories, ceiling tiles, or similar components, shall be scraped down, mechanically or by hand, to remove bumps or un-level surfaces to a condition that normal preparation and patching by subsequent trades is within normal trade standards.

3.07 SALVAGE

A. Unless noted otherwise, all salvageable items determined to be of value, including, but not limited to, casework, stainless steel, toilet accessories, toilet partitions, copper wiring, plumbing fixtures, mechanical equipment, copper wiring, lighting fixtures, structural steel, shall be carefully removed, cleaned, and stored in the staging area. Notify the District Facilities Planning representative in writing that there are salvageable items for their review. If, after 72 hours of receipt of notification, the items have not been removed, the Contractor shall legally dispose of them. The 72-hour time period does not include weekends or holidays and shall start upon Facilities Planning's receipt of written notice.

B. The District shall be able to examine and remove any of the items salvaged from the project. It is the Contractor's responsibility to protect the salvaged items during the 72-hour period. Should any of the salvaged items be disposed before the District has examined them, the Contractor shall reimburse the District for these items.

C. The Owner reserves the right to retain ownership of any equipment, fixtures, or materials removed from the property.

1. Removed equipment and fixtures shall be stored neatly in an area designated by the Owner for a period of 72 weekday hours.

**SELECTIVE BUILDING DEMOLITION
SECTION 02 41 19**

2. Items that are not claimed by the Owner within the 72-hour time period shall be removed from the site and properly disposed.
 3. Improvements or materials removed from the building shall not be transferred by sale, gift, or in any manner whatsoever to the general public.
 - a. Sale or disposal to duly licensed contractors or materialmen is permitted.
 - b. Contractor shall assume all responsibilities arising out of such operation.
- D. Items indicated to be removed, but of salvageable value to the Contractor may be removed from structure as work progresses.
1. Transport salvaged items from site as they are removed. Storage of removed items onsite will not be permitted.
 2. Items or materials removed from the building shall not be transferred by sale, gift, or in any manner whatsoever to the general public.
 - a. Sale or disposal to duly licensed contractors or material-men is permitted.
 - b. Contractor shall assume all responsibilities arising out of such operation.

END OF SECTION 02 41 19

STRUCTURAL METAL STUD FRAMING

SECTION 05 41 00

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Load bearing and non-load bearing wall formed steel stud framing.
 - 3. Exterior wall sheathing.
 - 4. Floor and roof formed steel stud framing and bridging.
- B. Related Sections:
 - 1. Section 05 12 00: Structural Steel Framing
 - 2. Section 06 10 00: Rough Carpentry
 - 3. Section 07 92 00: Joint Sealants.

1.02 REFERENCES

- A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute.
- B. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- E. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- F. ASTM C 208 - Standard Specification for Cellulosic Fiber Insulating Board.
- G. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- H. ASTM C 955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
- I. ASTM C 1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- J. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum

Substrate for Use as Sheathing.

- K. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board.
- L. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.
- M. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society.
- N. PS 1 - Construction and Industrial Plywood; National Institute of Standards and Technology (Department of Commerce).
- O. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings.
- P. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings.
- Q. Steel Stud Manufacturers Association (SSMA) Product Technical Information ICC Report Number ER-4943P.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Submit product data for framing members, accessories, and connection devices.
 - 2. Describe materials, finish and section properties.
- B. Shop Drawings:
 - 1. Review of shop drawings by the Structural Engineer is not required for this project.
 - 2. Submit following Informational Submittals:
 - a. Qualification Data: Manufacturer's, erector's, and welder's qualification data.
 - b. Certifications specified in Quality Assurance article.

1.04 QUALITY ASSURANCE

- A. Erector Qualifications: Minimum of 5 years documented experience on comparable steel stud framing projects.
- B. Welder Qualifications: AWS certified within past 12 months for each type of weld required.
- C. Certifications:
 - 1. Submit certificates verifying AWS qualifications for each welder employed on Project.
 - 2. Submit fabricator's certification that products furnished for Project meet or exceed specified requirements.
 - 3. Engineering Certifications.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Section 01 60 00.

1.06 PROJECT CONDITIONS

- A. Field verify measurements. Architect will not review or take responsibility for dimensions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Studs:
 - 1. C-shape design, roll formed with punched web, 1-3/8inch minimum face flange and manufacturer's standard return lip.
 - 2. Galvanized or painted studs: Grade as required by design.
- B. Runners:
 - 1. Channel shaped; same width as studs, tight fit; solid web. Grade as required by design.
 - 2. Accessories, Plates, Gussets, Clips: Formed sheet steel, thickness determined for conditions encountered; same finish as framing members.
- C. Fasteners:
 - 1. Self-drilling, Self-tapping Screws, Bolts, Nuts and Washers: Size, type and spacing determined to suit Project conditions; ASTM A153, hot-dip galvanized, Class C or D as appropriate.
- D. Anchorage Devices: As required by design. Do not use powder activated anchors (shotpins) when subject to tensile forces (withdraw).
- E. Welding: In conformance with AWS D1.3.
- F. Galvanizing Touch-Up Paint: FS TT-P-641, zinc oxide type.
- G. Touch-Up Paint: Same as manufacturer's primer.

2.02 FABRICATION

- A. Fit and assemble in largest practical sections for delivery to site, ready for installation.
- B. Fabricate in accordance with requirements of ASTM C955.
- C. Cut framing components squarely for attachment to perpendicular members, or as required for angular fit against abutting members. Hold members positively in place until properly fastened.
- D. Fabricate studs of sizes and sheet metal thicknesses as required by design.

2.03 FINISHES

- A. Exterior Wall Components: Galvanized, ASTM A653 G90 coating.
- B. Interior Components: Galvanized, ASTM A653 G60 coating.
- C. Interior Components: FS TT-P-636, prime painted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with Work.

3.02 ERECTION

- A. Install components in accordance with manufacturer's printed instructions. Provide temporary bracing until erection is complete.
- B. Locate and align floor and ceiling runners according to layout on approved shop drawings. Anchor in place as required by design, 16 inches minimum on centers. Locate runner end joints between studs. Splice with length of stud cut to fit stud-to-stud. Anchor splice to each runner at ends and at each end of splice stud.
- C. Coordinate installation of required sealants with runner installation.
- D. Install studs plumb, level, and square, free from warp or twist while maintaining dimensional tolerances and alignment with adjacent surfaces.
- E. Place studs at uniform spacing shown on approved shop drawings with full bearing against inside web of runners. Align with all flanges facing same direction.
- F. Locate studs not more than 2 inches from abutting walls.
- G. Secure studs to runners with fasteners or welding of type and at spacing shown on approved shop drawings. Provide deflection allowance in top runners for non-load-bearing studs.
- H. Construct corners using minimum 3 studs. Provide multiple studs at wall openings, and at door and window jambs as required by design.
- I. Erect studs in one piece full length, brace, and reinforce to develop full strength to meet design requirements. Splicing of studs is not permitted, unless method of splicing is indicated on approved shop drawings.
- J. Install intermediate jack studs (cripples) above and below openings to match wall stud spacing.
- K. Brace studs that support fixtures, mechanical and electrical items with stud

sections or channel bridging as required by design to support applied loads without excess deflection or stress. Install additional framing members as required for attachment of fixtures.

- L. Attach bridging in manner to prevent stud rotation. Provide bridging at following locations and elsewhere as required by design:
- M. For Non-loadbearing Exterior Walls:
 - 1. Walls less than 10'-0" in height: 1 row mid-height of wall.
 - 2. Walls greater than 10'-0" in height: Maximum 5 feet on center.
- N. For Loadbearing Exterior Walls:
 - 1. Walls less than 10'-0" in Height: 2 rows equally spaced.
 - 2. Walls greater than 10'-0" in Height: Maximum 3'-4" on center.
- O. Tolerances:
 - 1. Maximum variation from true position: 1/4 inch.
 - 2. Maximum variation of any member from plane: 1/8 inch in 4'-0", non-cumulative.

3.03 ADJUSTING

- A. Touch-up field welds and damaged galvanized surfaces with appropriate primer.

END OF SECTION 05 41 00

METAL FABRICATIONS
SECTION 05 50 00

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Gratings
- B. Metal Walkways
- C. Steel Clips, Angles, Tubes, Pipes and Shapes.
- D. Anchors and Bolts

1.02 RELATED SECTIONS

- A. Section 05 51 33 Metal Ladders

1.30 SUBMITTALS

- A. Submit in accordance with Section 01 60 00, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data
- C. Shop Drawings:
 - 1. Each item specified, showing complete detail, location in the project, material and size of components, method of joining various components and assemblies, finish, and location, size and type of anchors.
 - 2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
 - 3. Provide templates and rough-in measurements as required.
- D. Manufacturer's Certificates:
 - 1. Factory finish as specified.
 - 2. Live load designs as specified.
- E. Design Calculations for specified live loads including dead loads.
- F. Furnish setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

**METAL FABRICATIONS
SECTION 05 50 00**

1.04 QUALITY ASSURANCE

- A. Each manufactured product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.
- B. Each product type shall be the same and be made by the same manufacturer.
- C. Assembled product to the greatest extent possible before delivery to the site.
- D. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

1.05 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - B18.6.1-97.....Wood Screws
 - B18.2.2-87(R2005).....Square and Hex Nuts
- C. American Society for Testing and Materials (ASTM):
 - A36/A36M-08 Structural Steel
 - A47-99(R2009).....Malleable Iron Castings
 - A48-03(R2008).....Gray Iron Castings
 - A53-10.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated
Welded and Seamless
 - A123-09.....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
Products
 - A167-99(R2009).....Stainless and Heat-Resisting Chromium-Nickel Steel
Plate, Sheet and Strip
 - A269-10.....Seamless and Welded Austenitic Stainless Steel
Tubing for General Service
 - A307-10.....Carbon Steel Bolts and Studs, 60,000 PSI Tensile
Strength

METAL FABRICATIONS
SECTION 05 50 00

- A312/A312M-09 Seamless, Welded, and Heavily Cold Worked
Austenitic Stainless Steel Pipes
- A391/A391M-07 Grade 80 Alloy Steel Chain
- A653/A653M-10 Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron
Alloy Coated (Galvannealed) by the Hot-Dip Process
- A786/A786M-09 Rolled Steel Floor Plate
- B221-08.....Aluminum and Aluminum-Alloy Extruded Bars, Rods,
Wire, Shapes, and Tubes
- B456-03(R2009).....Electrodeposited Coatings of Copper Plus Nickel Plus
Chromium and Nickel Plus Chromium
- B632-08.....Aluminum-Alloy Rolled Tread Plate
- C1107-08.....Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- D3656-07.....Insect Screening and Louver Cloth Woven from Vinyl-
Coated Glass Yarns
- F436-10 Hardened Steel Washers
- F468-10 Nonferrous Bolts, Hex Cap Screws, and Studs for
General Use
- F593-02(R2008) Stainless Steel Bolts, Hex Cap Screws, and Studs
- F1667-11 Driven Fasteners: Nails, Spikes and Staples
- D. American Welding Society (AWS):
- D1.1-10.....Structural Welding Code Steel
- D1.2-08.....Structural Welding Code Aluminum
- D1.3-08.....Structural Welding Code Sheet Steel
- E. National Association of Architectural Metal Manufacturers (NAAMM)
- AMP 521-01 Pipe Railing Manual
- AMP 500-06 Metal Finishes Manual
- MBG 531-09 Metal Bar Grating Manual
- MBG 532-09 Heavy Duty Metal Bar Grating Manual
- F. Structural Steel Painting Council (SSPC)/Society of Protective Coatings:
- SP 1-04 No. 1, Solvent Cleaning
- SP 2-04 No. 2, Hand Tool Cleaning

**METAL FABRICATIONS
SECTION 05 50 00**

SP 3-04 No. 3, Power Tool Cleaning

G. Federal Specifications (Fed. Spec):

RR-T-650E Treads, Metallic and Nonmetallic, Nonskid

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Manufactured steel clips and angles will be accepted where such will meet the requirements of the Contract Drawings and are shown on approved Shop Drawings
- B. Steel Materials:
 - 1. Shapes: Standard structural sections, shapes, plates, and bars, as indicated, conforming with ASTM A36. Bars conforming with ASTM A108 will be accepted.
 - 2. Tubing: Steel tubing conforming with ASTM A500 or ASTM A501, of size and shape indicated.
 - 3. Pipe: Steel pipe or round tubing, conforming to ASTM A53, Type E or S, Grade A, of diameters and sizes indicated. Pipe for sleeves and exterior locations shall be galvanized pipe as specified in ASTM A53.
- C. Welding Rods/Electrodes: Refer to Section 05 05 22 – Metal Welding for requirements.
- D. Castings: ASTM A27, A47, A48, or A536, as applicable to the work.
- E. Forgings: ASTM A668, of Class indicated or required.
- F. Anchors and Bolts: ASTM A307, A449, A563, and F436, as applicable. Bolts and studs, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A153.
- G. Fasteners and Accessories: Furnish anchors and fasteners, washers, straps, and accessories as required for a complete and finishes installation. Fasteners shall be stainless steel or galvanized steel as appropriate and approved for the location.
- H. Concrete and Masonry Anchors: Where anchors are not cast into the concrete or masonry construction, provide hot dip galvanized expansion type anchors with matching hot-dip galvanized steel bolts or studs with nuts, of sizes as indicated or required. Provide washers under all bolt heads and nuts.

METAL FABRICATIONS
SECTION 05 50 00

I. Gratings:

1. Bar-Type Gratings:

- a. Provide Swaged-Locked I-Bar type grating of all weld construction.
- b. Bar gratings shall be capable of supporting a uniform live load of 100 pounds per square foot and a concentrated load of 1,000 pounds.
- c. Supporting edges shall be L-shaped formed edges capable of supporting a uniform live load of 100 pounds per square foot and a concentrated load of 1,000 pounds.

J. Grout: ASTM C1107, pourable type.

2.02 HARDWARE

A. Rough Hardware:

- 1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated, or zinc-coated by electro-galvanizing process. Galvanized G-90 where specified.
- 2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

B. Fasteners:

1. Bolts with Nuts:

- a. ASME B18.2.2.
- b. ASTM A307 for 415 MPa (60,000 psi) tensile strength bolts.
- c. ASTM F468 for nonferrous bolts.
- d. ASTM F593 for stainless steel.

2. Screws: ASME B18.6.1.

3. Washers: ASTM F436, type to suit material and anchorage.

2.03 FABRICATION GENERAL

A. Material

- 1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
- 2. Use material free of defects, which could affect the appearance or service ability of the finished product.

METAL FABRICATIONS
SECTION 05 50 00

B. Size:

1. Size and thickness of members as shown.
2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

C. Connections

1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
2. Field riveting will not be approved.
3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
4. Holes, for rivets and bolts: Accurately punched or drilled and burrs removed.
5. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
6. Use Rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
7. Use stainless steel connectors for removable members machine screws or bolts.

D. Fasteners and Anchors

1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self drilling and tapping screws or bolts.

METAL FABRICATIONS
SECTION 05 50 00

E. Workmanship

1. General:

- a. Fabricate items to design shown.
- b. Furnish members in longest lengths commercially available within the limits shown and specified.
- c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
- d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.
- e. Provide openings, cut-outs, and tapped holes for attachment and clearances required for work of other trades.
- f. Prepare members for the installation and fitting of hardware.
- g. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.

2. Welding:

- a. Weld in accordance with AWS.
- b. Welds shall show good fusion, be free from cracks and porosity and accomplish secure and rigid joints in proper alignment.
- c. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
- d. Finish welded joints to match finish of adjacent surface.

3. Joining:

- a. Miter or butt members at corners.
- b. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.

4. Anchors:

- a. Where metal fabrications are shown to be preset in concrete, weld 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 150 mm (6 inches) long with 25

METAL FABRICATIONS
SECTION 05 50 00

mm (one inch) hooked end, to back of member at 600 mm (2 feet) on center, unless otherwise shown.

5. Cutting and Fitting:

- a. Accurately cut, machine and fit joints, corners, copes, and miters.
- b. Fit removable members to be easily removed.
- c. Design and construct field connections in the most practical place for appearance and ease of installation.
- d. Fit pieces together as required.
- e. Fabricate connections for ease of assembly and disassembly without use of special tools.
- f. Joints firm when assembled.
- g. Conceal joining, fitting and welding on exposed work as far as practical.
- h. Do not show rivets and screws prominently on the exposed face.
- i. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.

F. Finish:

1. Finish exposed surfaces in accordance with NAAMM Metal Finishes Manual.
2. Aluminum: NAAMM AMP 501.
 - a. Mill finish, AA-M10, as fabricated, use unless specified otherwise.
 - b. Clear anodic coating, AA-C22A41, chemically etched medium matte, with Architectural Class 1, 0.7 mils or thicker.
 - c. Colored anodic coating, AA-C22A42, chemically etched medium matte with Architectural Class 1, 0.7 mils or thicker.
 - d. Painted: AA-C22R10.
 - e. Organic Coating: Thermally cured fluoropolymer (Kynar 500) finish, 0.3 mil primer and 0.8 mil finish color coat (minimum).
3. Steel and Iron: NAAMM AMP 504.
 - a. Zinc coated (Galvanized): ASTM A123, G90 unless noted otherwise.
 - b. Surfaces exposed in the finished work:

METAL FABRICATIONS
SECTION 05 50 00

- 1) Finish smooth rough surfaces and remove projections.
- 2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.
- c. Shop Prime Painting:
 - 1) Surfaces of Ferrous metal:
 - a) Items not specified to have other coatings.
 - b) Galvanized surfaces specified to have prime paint.
 - c) Remove all loose mill scale, rust, and paint, by hand or power tool cleaning as defined in SSPC-SP2 and SP3.
 - d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP1.
 - e) After cleaning and finishing apply one coat of primer as specified in Section 09 91 00, PAINTING.
 - 2) Non ferrous metals: Comply with MAAMM-500 series.
4. Stainless Steel: NAAMM AMP-504 Finish No. 4.
5. Chromium Plating: ASTM B456, satin or bright as specified, Service Condition No. SC2.
- G. Protection:
 1. Insulate aluminum surfaces that will come in contact with concrete, masonry, plaster, or metals other than stainless steel, zinc or white bronze by giving a coat of heavy-bodied alkali resisting bituminous paint or other approved paint in shop.
 2. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal, using zinc rich paint on hot-dip zinc coat items and zinc dust primer on all other zinc coated items.

2.04 SUPPORTS

- A. General:
 1. Fabricate ASTM A36 structural steel shapes as shown.
 2. Use clip angles or make provisions for welding hangers and braces to overhead construction.
 3. Field connections may be welded or bolted.

METAL FABRICATIONS
SECTION 05 50 00

4. Provide a continuous steel angle and walk frame spaced as shown.
5. Fabricate from steel channels, or combination of steel plates and angles to size and contour shown.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set work accurately, in alignment and where shown, plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Field weld in accordance with AWS.
 1. Design and finish as specified for shop welding.
 2. Use continuous weld unless specified otherwise.
- C. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.
- E. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.
- F. Isolate aluminum from dissimilar metals and from contact with concrete and masonry materials as required to prevent electrolysis and corrosion.
- G. Secure escutcheon plate with set screw.

3.2 INSTALLATION OF SUPPORTS

- A. Anchorage to structure.
 1. Secure angles or channels and clips to overhead structural steel by continuous welding unless bolting is shown.
 2. Secure supports to concrete inserts by bolting or continuous welding as shown.
 3. Fasten clips to concrete with expansion bolts, and to steel with machine bolts or welds.

METAL FABRICATIONS
SECTION 05 50 00

3.12 CLEAN AND ADJUSTING

- A. Adjust movable parts including hardware to operate as designed without binding or deformation of the members centered in the opening or frame and, where applicable, contact surfaces fit tight and even without forcing or warping the components.

END OF SECTION

METAL LADDERS

SECTION 05 51 33

PART 1 GENERAL INFORMATION

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Aluminum ladder and brackets;
 - 3. Accessories and associated hardware;
 - 4. Submittal preparation;
 - 5. Clean up.
- B. Related Sections:
 - 1. Section 05 50 00: Metal Fabrications
 - 1. Section 06 10 00: Rough Carpentry

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Submit copies of product data to the Architect for review prior to beginning fabrication.
 - 2. Submit copies of manufacturer's installation instructions to the Architect for review prior to beginning fabrication.
- B. Shop Drawings or Layout Drawings:
 - 1. Submit copies of shop drawings to the Architect for review prior to beginning fabrication.
 - a. Include sizes, types, finishes, scheduled locations, and details of adjoining work.

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Completed installation shall comply with the requirements of CAL/OSHA and California Administrative Code, Title 8.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Alaco Ladder Company:
 - 1. Quality Standard: Caged fixed wall ladder with handrails over roof - Model No. 561C
 - 2. Quality Standard: Side Exit Ladder - Model No. 561-SE.
 - 3. Quality Standard: Handrails Over Roof – Model No. 561
 - 4. Quality Standard: Fixed Wall Ladder – Model No. 560
- B. Or equal.

METAL LADDERS

SECTION 05 51 33

2.02 MATERIALS

- A. Aluminum ladders and their components are fabricated from 6061-T6 aluminum alloy, with no painting required.
- B. Model 560 & 561 ladders include side rails with 1-1/8" round rungs that are serrated and secured with cast aluminum connectors, 4 solid rivets and 3/8" thick brackets mounted to the walls.
 - 1. Rungs shall withstand 1000 lb. load.
- C. Cages consist of 1/4" x 2" hoops and seven 3/16" x 1-1/2" vertical bars, with solid riveted connections.
 - 1. Cages are required for wall ladders when installations are in excess of 20' in height.
- D. Rest Platforms – These platforms consist of GripStrut floors, 4" high toe boards, 1-1/4" serrated tube guard railings and cast aluminum railing fittings.
 - 1. Platforms required for ladders over 30'.

2.03 FINISH

- A. Mill finish is standard on aluminum ladders.
- B. Factory applied paint coatings and chem-film treatment for field applied primers are available upon request.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all required backing and blocking prior to enclosing framing.
- B. Verify layout prior to beginning work.
- C. Verify rough openings and correct location.
- D. Start of work shall be considered as acceptance of existing conditions.

3.02 INSTALLATION OR APPLICATION

- A. Install per the manufacturer's latest written recommendations.
- B. Install frame plumb and level in wall and ceiling openings.
- C. Position to provide convenient access.
- D. Secure rigidly in place in accordance with manufacturer's instructions.
- E. Maximum wall bracket support spacing is 6'-0" on center.
- F. Anchor to concrete floor & wall with Hilti Kwik Bolts, or equal.

**METAL LADDERS
SECTION 05 51 33**

3.03 CONDITION OF FINISHED WORK

- A. Completed installation shall be clean, plumb, true-to-line, and securely attached.
- B. Side rails shall extend to within 6" of roof hatch lid.

END OF SECTION

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

PART 1 GENERAL

1.01 SUMMARY

A. Inclusions:

1. Provisions set forth in Divisions 0 and 1
2. Preparation of new roof deck, and all flashing substrates.
3. Mechanically and adhesive attached PVC membrane
4. Sheet metal flashings and sheet metal roof edge system.
5. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

B. Related Sections:

1. Section 06 10 00: Rough Carpentry.
2. Section 07 62 00: Sheet Metal Flashing and Trim.

1.02 References:

- A. AMERICAN SOCIETY OF CIVIL ENGINEERS - Reference Document ASCE 7, Minimum Design Loads for Buildings and Other Structures.
- B. AMERICAN STANDARD OF TESTING METHODS (ASTM):
- C. ASTM D 4434 - Standard Specification for Polyvinyl Chloride (PVC) Sheet Roofing.
- D. ASTM D 570 - Standard Test Method for Water Absorption of Plastics.
- E. ASTM C 726 - Standard Specification for Mineral Wool Roof Insulation Board.
- F. ASTM C 728 - Standard Specification for Perlite Thermal Insulation Board.
- G. ASTM C 836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
- H. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants
- I. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- J. ASTM C 1278 - Standard Specification for Fiber-Reinforced Gypsum Panel.
- K. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board.
- L. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.
- M. ASTM E 1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- N. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):
 1. ANSI/SPRI/FM 4435/ES-1 Wind Design Standard for Edge System Used with Low Slope Roofing System.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

2. ANSI/SPRI FX-1, Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
 3. ANSI/SPRI IA-1, Standard Field Test Procedure for Determining the Mechanical Uplift Resistance of Insulation Adhesives over Various Substrates.
 4. ANSI/FM 4474- American National Standard for Evaluating the Simulated Wind Resistance of Roof Assemblies Using Static Positive and/or Differential Pressures.
- O. FACTORY MUTUAL (FM):
- P. FM 4470 - Approval Standard - Class I Roof Covers.
- Q. INTERNATIONAL CODES COUNCIL (ICC):
- R. 2016 International Building Code (IBC).
- S. NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA).
- T. SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION INC. (SMACNA) Architectural Sheet Metal Manual.
- U. UNDERWRITERS LABORATORY (UL):
- V. UL 790 Standard Test Methods for Fire Tests of Roof Coverings.
- W. UL 1256 – Fire Test of Roof Deck Constructions.

1.03 Definitions:

- A. ASTM D 1079-Definitions of Term Relating to Roofing, Waterproofing and Bituminous Materials.
- B. The National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual, Fifth Edition Glossary.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Product Data Sheets: Submit manufacturer's product data sheets, installation instructions and/or general requirements for each component.
 2. Material Safety Data Sheets: Submit manufacturer's Material Safety Data Sheets (MDS) for each component.
 3. Sample/Specimen Warranty from the manufacturer and contractor.
 4. Shop Drawings: Provide typical details for conditions to be encountered on this project.
- B. Informational Submittals
 1. Contractor Certification: Submit written certification from roofing system manufacturer certifying that the applicator is authorized by the manufacturer to install the specified materials and system.
- C. Closeout Submittals:
- D. Warranty: Provide manufacturer's and contractor's warranties upon substantial completion of the roofing system.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer shall have 10 years of experience manufacturing PVC – thermoplastic polyvinyl chloride roofing materials.
2. Trained Technical Field Representatives, employed by the manufacturer, independent of sales.
3. Provide reports in a timely manner of all site visit reports.
4. Provide specified warranty upon satisfactory project completion.

B. Contractor Qualifications:

1. Contractor shall be authorized by the manufacturer to install specified materials prior to the bidding period through satisfactory project completion.
2. Applicators shall have completed projects of similar scope using same materials as specified herein.
3. Contractor shall provide full time, on-site superintendent or foreman experienced with the specified roof system through satisfactory project completion.
4. Applicators shall be skilled in the application methods for all materials.
5. Contractor shall maintain a daily record, on-site, documenting material installation and related project conditions.
6. Contractor shall maintain a copy of all submittal documents, on-site, available at all times for reference.

C. Warranty:

1. Manufacturer's No Dollar Limit (NDL), Labor and Material Warranty. The manufacturer shall provide the owner with the manufacturer's labor and material warranty covering products and contractor workmanship for twenty (20) years from the date the warranty is issued.
2. The contractor shall guarantee the workmanship and shall provide the owner with the contractor's warranty covering workmanship for a period of two (2) years from completion date.

1.06 DELIVERY, STORAGE AND HANDLING

- A.** Refer to each product data sheet or other published literature for specific requirements.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

- B. Deliver materials and store them in their unopened, original packaging, bearing the manufacturer's name, related standards, and any other specification or reference accepted as standard.
- C. Protect and store materials in a dry, well-vented, and weatherproof location. Only materials to be used the same day shall be removed from this location. During cold weather, store materials in a heated location, removed only as needed for immediate use.
- D. When materials are to be stored outdoors, store away from standing water, stacked on raised pallets or dunnage, at least 4 in or more above ground level. Carefully cover storage with "breathable" tarpaulins to protect materials from precipitation and to prevent exposure to condensation.
- E. Carefully store roof membrane materials delivered in rolls on-end with selvage edges up. Store and protect roll storage to prevent damage.
- F. Properly dispose of all product wrappers, pallets, cardboard tubes, scrap, waste, and debris. All damaged materials shall be removed from job site and replaced with new, suitable materials.

1.07 SITE CONDITIONS

- A. Safety:
 - 1. The contractor shall be responsible for complying with all project-related safety and environmental requirements.
 - 2. Heat-welding shall include heating the specified membrane ply using electric hot-air welding equipment. The contractor shall determine when and where conditions are appropriate to utilize heat-welding equipment.
 - 3. Refer to NRCA CERTA recommendations, local codes and building owner's requirements for hot work operations.
 - 4. The contractor shall review project conditions and determine when and where conditions are appropriate to utilize the specified liquid-applied or semi-solid roofing materials. When conditions are determined by the contractor to be unsafe or undesirable to proceed, measures shall be taken to prevent or eliminate the unsafe or undesirable exposures and conditions, or equivalent approved materials and methods shall be utilized to accommodate requirements and conditions.
 - 5. The contractor shall refer to product Material Safety Data Sheets (MSDS) for health, safety, and environment related hazards, and take all necessary measures and precautions to comply with exposure requirements.
- B. Environmental Conditions:

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

1. Monitor substrate temperature and material temperature, as well as all environmental conditions such as ambient temperature, moisture, sun, cloud cover, wind, humidity, and shade. Ensure conditions are satisfactory to begin work and ensure conditions remain satisfactory during the installation of specified materials. Materials and methods shall be adjusted as necessary to accommodate varying project conditions. Materials shall not be installed when conditions are unacceptable to achieve the specified results.
2. Precipitation and dew point: Monitor weather to ensure the project environment is dry before, and will remain dry, during the application of roofing materials. Ensure all roofing materials and substrates remain above the dew point temperature as required to prevent condensation and maintain dry conditions.
3. Membrane Adhesive application: During cold weather, store the specified membrane adhesives, cements and mastics in heated storage areas. Take all necessary measures and monitor application conditions, to ensure the adhesive and cement materials are no less than 70F (21C) at the point of contact with the membrane.
4. Heat-Welding Application: Take all necessary precautions and measures to monitor conditions to ensure all environmental conditions are safe to proceed with the use of hot-air welding equipment. Combustibles, flammable liquids and solvent vapors that represent a hazard shall be eliminated and primers shall be fully dry before proceeding with heat-welding operations. Refer to NRCA CERTA recommendations.

1.08 PERFORMANCE REQUIREMENTS

A. Wind Uplift Resistance:

1. Performance testing shall be in accordance with ANSI/FM 4474, FM 4450, FM 4470, UL 580 or UL 1897.

B. Fire Classification:

1. Performance testing shall be in accordance with UL 790, ASTM E108, FM 4450 or FM 4470 to meet the roof slope requirement.
2. Meets requirements of UL Class A or FM Class A.
3. Performance testing shall be in accordance with UL 1256, FM 4450 or FM 4470 to meet the specified requirements for interior flame spread and fuel contribution.
4. Meets requirements of UL 1256, or FM Class 1.

C. Roof Slope:

1. Finished roof slope for PVC surfaces shall be ¼ inch per foot (2 percent) minimum for roof drainage, including valleys.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

D. Impact Resistance:

1. Performance testing for impact resistance shall be in accordance with FM 4450, FM 4470, ASTM D3746 or CGSB 37-GP 56M to meet the specified impact resistance requirements.
2. Meets requirements for FM-SH (Severe Hail), ASTM D3746, or CGSB 37-GP 56M.

E. Energy-Star Rating:

1. The roof membrane shall meet the approval requirements of the US EPA EnergyStar Program. Cap sheet shall be surfaced with highly reflective, factory-applied, tri-laminate film surfacing. (SOPREMA Soprapstar cap sheet basis of design):
2. Membrane Cap Sheet shall be an EnergyStar Approved Product.
 - a. Solar Reflectance: Initial: 0.78 3-year: 0.74
 - b. Thermal Emittance: Initial: 0.89 3-year: 0.66
 - c. Solar Reflectance Index (SRI): Initial 97 3-year: 86

F. Energy Conservation Requirements:

1. Polyisocyanurate Insulation "R" Value: Long-term thermal resistance (LTTR) values of the specified foam insulation shall be determined in accordance with CAN/ULC-S770.
2. Polyisocyanurate Insulation "R" Value: Shall be determined in accordance with ASTM C1289-11a.
3. Thermal Resistance 'R' for the specified roof insulation system shall include the continuous insulation (ci) above the roof deck.
4. Total Thermal Resistance R Value, continuous insulation (ci) above-deck: R(00)

G. Roof Edge System Securement:

1. Performance testing in accordance with ANSI/SPRI ES-1.
2. Performance testing meets requirements for specified roof system design pressures.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. SINGLE SOURCE MANUFACTURER: All PVC membrane and flashing sheets shall be manufactured by a single supplier with 10 years or more manufacturing history.

B. PRODUCT QUALITY ASSURANCE PROGRAM: Manufacturer shall be an ISO 9001add other ISO;s registered company. A 'Quality Compliance Certificate

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

(QCC) for reporting/confirming the tested values of the SBS-Modified Bitumen Membrane Materials will be supplied upon request.

C. ACCEPTABLE MANUFACTURER:

1. Sika Sarnafil PVC, located at: 15616 Euclid Ave · Chino · CA · 91708;
Phone: 1-559-240-7576; Website: usa.sarnafil.sika.com
2. Acceptable Alternate Manufacturers: Soprema, GAF & Carlisle.

2.02 ROOFING SYSTEM

A. Roofing System Basis of Design:

1. Sarnafil G410

B. Rigid Insulation:

C. Closed cell polyisocyanurate rigid foam insulation board with glass reinforced facer on each side.

1. Meet ASTM D3273 for mold resistance
2. At concrete deck use low rise foam adhesive per manufacturer's recommendations to install one layer of 2" thick insulation.
3. At metal deck use #12 sheet metal screws and #12 galvanized plates to install one layer of 4" thick insulation.

D. Self adhered Roof Cover Board:

1. Georgia-Pacific DensDeck Prime.
 - A. Fiberglass mats with gypsum core
 - B. 1/4" minimum thickness
 - C. Mold resistant per ASTM D 3273 test method.
 - D. Regulatory Requirements: Provide products that comply with the following limits for surface burning characteristics when tested per ASTM E84:
 1. Flame spread: 15, maximum.
 2. Smoke developed: 0.
 - E. Use low rise foam adhesive per manufacturer's recommendations.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

E. Self adhered Membrane:

1. Membrane sheet, self adhered:
 - A. Sarnafil G410 Membrane: Thermoplastic Polyvinyl chloride, polyester reinforced membrane manufactured by SIKA.
 1. Thickness: Nominal 60 mils (1.5 mm) with maximum variations of -5/+10%.
 2. Meets or exceeds ASTM D 4434
 3. Compound thickness above polyester reinforcement must be a minimum 30 mils
 4. Width: 82.5 inches (2 meters)
 5. Use low rise foam adhesive per manufacturer's recommendations.

2.03 ACCESSORIES

A. Primers:

1. Vapor Retarder Primer VC: VOC compliant, solvent based primer used to prime wood, concrete, lightweight concrete, approved gypsum boards, and gypsum decks prior to the application of Sika's self-adhered vapor retarders.

B. Vapor Retarder:

1. Vapor Retarder SA 106: 106 mil thick self-adhesive vapor retarder for use within Sarnafil roofing systems.
 - a. Self-adhering side laps to simplify installation.
 - b. Sanded surface accepts approved urethane adhesives for insulation or membrane attachment.

C. Cut Edge Sealant:

1. Sikaflex – 1A Elastomeric joint sealant / adhesive: General purpose, sealant used to seal all edges that are field cut.
 - a. Meets or exceeds ASTM C920, Type S, Grade NS, Class 35.

D. Walkways:

1. Sikaplan Walkway 20: Thermoplastic rolled-out, heat welded walkway. Used to protect roof membrane and provide path for foot traffic.
 - a. Thickness: 79 mils (2 mm)
 - b. Width: 39"

E. Membrane Fasteners and Plates:

1. #12 sheet metal screws and #12 galvanized plates.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

F. Sheet Metal Flashing:

1. Sarnaclad – PVC Coated heat-weldable metal used for all metal flashings, roof edge systems and other related sheet metal flashings.
2. Sheet metal flashing materials and fasteners shall be compatible with adjacent materials, to accommodate all project related exposures.
3. Roof Edge System: Tested per ANSI/SPRI ES-1 to meet or exceed design pressures at roof edge.

G. Sheet Metal, Roof Edge System:

1. Roof edge system shall include all components and associated fasteners included by the manufacturer to comply with specified performance requirements. Contractor shall provide all other related fasteners and sealants not provided as part of the roof edge system, and required in the manufacturer's product data sheets.
2. Sika Wall Grip Coping Parapet Coping: Engineered metal coping with hold-down cleats and metal chairs for capping most any parapet.
 - a. Material: Galvanized Steel
 - b. Gauge/Thickness: 24 Galvanized Steel
 - c. Cleat: 20 gauge Galvanized Steel
 - d. Finish: Mill finish, Kynar 700 Colors, Clear Anodize & Bronze Anodize.
 - e. Tested per ANSI/SPRI ES-1 to meet or exceed design pressures at roof edge.
 - f. FM Approved.

PART 3 EXECUTION

3.01 PRE-INSTALLATION MEETINGS

- A. Convene prior to commencing work at a time and location to be determined by the Owner/Owner's Representative.

3.02 EXAMINATION

- A. Examination includes visual observations, qualitative analysis, and quantitative testing measures as necessary to ensure conditions remain satisfactory throughout the project.
- B. The contractor shall examine all roofing substrates including, but not limited to: insulation materials, roof decks, walls, curbs, rooftop equipment, fixtures, and wood blocking.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

- C. The applicator shall not begin installation until conditions have been properly examined and determined to be clean, dry and, otherwise satisfactory to receive specified roofing materials.
- D. During the application of specified materials, the applicator shall continue to examine all project conditions to ensure conditions remain satisfactory to complete the specified roofing system.

3.03 PREPARATION

- A. Before commencing work each day, the contractor shall prepare all roofing substrates to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.
- B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate contractor's acceptance of conditions.

3.04 INSULATION SYSTEM APPLICATION

- A. Follow insulation system component product data sheets, published general requirements and, approvals.
- B. Install all insulation system components on clean, dry, uniform and, properly prepared substrates.
- C. All insulation system boards shall be carefully installed and fitted against adjoining sheets to form tight joints.
- D. Insulation system boards that must be cut to fit shall be saw-cut or knife-cut in a straight line, not broken. Chalk lines shall be used to cut insulation components. Uneven or broken edges shall not be accepted. Remove dust and debris that develops during cutting operations.
- E. Stagger successive layers of insulation 12 in vertically and laterally to ensure board joints do not coincide with joints from the layers above and below.
- F. Crickets, saddles, and tapered edge strips shall be installed before installing Cover-boards.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

- G. Install tapered insulation, saddles and crickets as required to ensure positive slope for complete roof drainage.
- H. Cover-boards shall be installed to fit tight against adjacent boards. When required by the Cover-board manufacturer, a uniform gap shall be provided between Cover-boards using a uniform guide placed between board joints to form a gap between all boards during installation.
- I. The finished insulation system surface shall be tight to, and flush with, adjacent substrates to form a satisfactory substrate to install specified roof membrane and flashings.
- J. Install specified cants where required for membrane flashing transitions.

3.05 INSULATION FASTENER APPLICATION

- A. Fasten Thermal Barrier, Insulation Base Layer, Insulation, Cover-board to the deck using specified insulation fasteners and plates.
- B. Evenly distribute fasteners as required by the board manufacturer's published requirements.
- C. Fasten the insulation to meet the specified wind uplift resistance performance requirements and warranty requirements.
- D. Minimum insulation fastening requirement:
- E. Field of Roof: 12 fasteners per board, 12" x 24" minimum pattern.
- F. For insulation and Cover-boards located partially within the defined perimeter and/or corners, install fastening for the entire board as specified herein.

3.06 INSULATION ADHESIVE APPLICATION

- A. Apply the specified two-component insulation adhesive to adhere Insulation Base Layer, Insulation Layers, Cover-board to the deck and insulation substrate(s).
- B. Follow insulation adhesive product data sheets and published general requirements for installation requirements.
- C. Apply insulation adhesive in uniform ribbons, 1/2 in to 3/4 in wide.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

- D. Immediately install insulation components into insulation adhesive, and apply weight to ensure the materials maintain full contact with all ribbons for complete adhesion. Do not allow insulation adhesive to skin-over before placing the insulation materials into the adhesive.
- E. Adhere the insulation system to meet the specified wind uplift resistance performance and specified warranty requirements.
- F. Minimum insulation adhesive ribbon spacing:
 - 1. Field of Roof (Zone 1): 12 in on-centers.
 - 2. Perimeter of Roof (Zone 2): 6 in on-centers.
 - 3. Corners of Roof (Zone 3): 4 in on-centers.

3.07 PRIMER APPLICATION

- A. Apply the appropriate specified primer to dry, compatible substrates as required to enhance adhesion of new specified roofing materials.
- B. Apply primer using brush, roller, or sprayer at the rate published on the product data sheet.
- C. Fully prime substrates using brush, roller, or sprayer at the application rate published in the product data sheet
- D. Self-Adhered Membrane Primer: Apply Vapor Retarder Primer VC to dry, compatible substrates as required to enhance adhesion of self-adhered membrane plies. Ensure self-adhered membrane primer is tacky to-the-touch, but not wet. Primer should not transfer to the finger tips when touched.
- E. Do not proceed applying self-adhered membrane if primer is wet. If self-adhered membrane primer becomes fully dry and loses all tack, re-prime the substrate as necessary to achieve membrane adhesion.
- F. Project conditions vary throughout the day. Monitor changing conditions, monitor the drying time of primers, and monitor the adhesion of the membrane plies. Adjust primer and membrane application methods as necessary to achieve the desired results.

3.08 MEMBRANE ATTACHMENT

- A. Membrane sheet shall be oriented such that fastener rows (seams) run perpendicular to the steel deck rib direction in all field, perimeter, and corner areas.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

- B. Unroll and position roofing membrane, without stretching, over the approved substrate.
- C. Sheets are to be overlapped a minimum of 6.0”.
- D. Membrane shall be unrolled, lining up edge of roll with adjacent sheet.
- E. Membrane shall be installed in a neat and orderly fashion.
- F. Fastener spacings depend on building location, parapet height, building height, deck type, and deck thickness. Maximum spacing for fasteners is 24” o.c. for required field sheets, perimeter sheets, and added rows of fasteners. Fasteners must penetrate top flanges of metal decking where existing.
- G. Seaming area is to be clean and free of dust, dirt, and debris. When cleaning is required, follow the Manufacturer’s procedures for cleaning.
- H. All seams are to be welded using a hot air welder. All seams are to be welded daily. All T-laps shall be patched, using heat welded membrane.
- I. All seams are to be fully welded a minimum of 1.5" from the edge of the lap joint.
- J. Seams are to be allowed to cool and then checked for fish mouths and other voids. All necessary repairs are to be made daily by hot air welding.
- K. Membrane is to be secured at the roof perimeter by one of the following methods:

3.09 FLASHING ADHESIVE

- A. The minimum ambient temperature is 40°F (4°C) and rising.
- B. The canister temperature must be above 65°F (18°C) during application.
- C. Apply the Sarnacol – 2175 membrane adhesive using portable spray system.

3.10 SHEET METAL FLASHING APPLICATION

- A. Refer to sheet metal flashing detail drawings, and follow product data sheets and published general requirements for installation instructions.

POLYVINYL-CHLORIDE (PVC) ROOFING
SECTION 07 54 16

- B. Follow the most recent edition of the SMACNA Architectural Sheet Metal Manual for fabrication and installation requirements.

3.11 WALKWAYS

- A. At areas outlined on the drawings, and around the perimeter of all rooftop equipment and at all door and stair landings, install walkway protection.
- B. Cut walkway from end of rolls. No piece shall be less than 24 in.
- C. Provide a 2 in space between sheets for drainage.

3.12 CLEAN-UP

- A. Clean-up and properly dispose of waste and debris resulting from these operations each day as required to prevent damages and disruptions to operations.

END OF SECTION

**SHEET METAL FLASHING AND TRIM
SECTION 07 62 00**

PART 1 GENERAL INFORMATION

1.01 SUMMARY

A. Inclusions:

1. Provisions set forth in Divisions 0 and 1;
2. Sheet metal work;
 - a. Gutters, downspouts, splash pans, drip flashing, wall caps, metal edging, flashing, diverters, scuppers, etc.
 - b. Counter-flashing, patent flashing.
 - c. Louvers, screens, grilles, etc.
 - d. Expansion joints not included in other sections.
 - e. Clips and fasteners for sheet metal work and trim.
 - f. Sheet metal reveals or accents.
3. Reglet and flashing system;
4. Aluminum work not included in other sections;
5. Stainless steel work not included in other sections;
6. Submittal preparation;
7. Clean up.

B. Related Sections:

1. Section 06 10 00:	Rough Carpentry
2. Section 07 54 16:	Polyvinyl-Chloride (PVC) Roofing
3. Section 07 72 00:	Roof Accessories
4. Section 07 92 00:	Joint Sealants
5. Section 23 00 00:	Heating Ventilating & Air-Conditioning
6. Section 08 62 23:	Tubular Daylighting Devices

C. Performance Requirements:

1. Flashing Systems:
 - a. Completed work shall, in conjunction with roofing, doors, windows, equipment, and building finish materials, form a complete barrier against water.

1.02 SUBMITTALS

A. Product Data:

1. Submit copies of product data and installation recommendations of standard commercial items proposed for use on this project.

B. Shop Drawings or Layout Drawings:

1. Submit copies of shop drawings to the Architect for review prior to beginning fabrication.
 - a. Show details, joint configurations, anchorage, and materials used.

**SHEET METAL FLASHING AND TRIM
SECTION 07 62 00**

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Comply with latest published recommendations found in the Architectural Sheet Metal Manual published by the Sheet Metal and Air Conditioning Contractor's National Association.
 - 2. Comply with manufacturer's recommendations.
- B. Roofing Pre-Application Meeting:
 - 1. A representative of the contractor shall attend to coordinate the application of roof-related items.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Galvanized Sheet Steel:
 - 1. Use 26-gauge minimum thickness material, unless otherwise noted.
 - 2. Material shall be copper bearing with heavy galvanized finish.
 - a. Hot dip galvanized.
 - b. Minimum coating weight of 1.25 oz./sf.
 - c. Conform to ASTM A-525.
- B. Reglet and Flashing System:
 - 1. Two part reglet and flashing system consisting of reusable counter flashing that snaps into reglet.
 - a. Quality Standard: Springlok flashing system with type SM reglet by Fry Reglet Corp.
- C. Exposed Formed Flashings, Gutters, and Parapet Caps:
 - 1. 24 ga. Galvalume 55% Al-Zn) with factory applied Kynar 500 fluoropolymer coating.
 - 2. Color selected by Architect.
- D. Roof Expansion Joint Cover:
 - 1. Style: As indicated on Drawings.
 - 2. Joint Bellows Width: 3 inch.
 - 3. Bellows: 0.060 inch thick non-reinforced black EPDM bellows adhesively and mechanically combined to metal flanges by bifurcation process.
 - 4. Bellows Support: Closed-cell foam, 3/8 inch minimum thickness.
 - 5. Flange Metal: 26 gage G60 hot dipped galvanized steel.
 - 6. Provide matching factory-fabricated corners, transitions, intersections, and terminations.
 - 7. Fasteners: Corrosion-resistant fasteners compatible with flange metal and equivalent in corrosion resistance, of proper length and type for substrate.
 - 8. Quality Standard: Johns Manville Expand-O-Flash.

SHEET METAL FLASHING AND TRIM

SECTION 07 62 00

- E. Sheet Aluminum:
 - 1. Use 0.040 gauge minimum thickness material, unless otherwise noted.
 - 2. Material shall be Alcoa aluminum, 35 alloy alumilite satin finish, unless noted otherwise.
- F. Stainless Steel:
 - 1. U.S. Steel 18-8 No. 302, with #4 finish.
- G. Solder shall comply with ASTM B-32.
- H. Flux shall be raw muriatic acid.

2.02 ATTACHMENTS

- A. Wall Cap System:
 - 1. Wall cap flashing shall lock to hold down cleats per manufactured wall cap system. Hold down cleats and splice plates shall be as required by the manufacturer of wall cap system.
- B. Nails:
 - 1. Nails shall be galvanized.
- C. Rivets:
 - 1. Soft annealed non-corrosive type with rust-resistant coating.
- D. Screws:
 - 1. Screws and washers shall be cadmium-plated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all required backing and blocking prior to enclosing framing.
- B. Verify framing or surfaces are acceptable prior to installing finish materials.
 - 1. Preparatory work is complete.
 - 2. Subsurface is plumb, straight, and true.
 - 3. Surface is securely fastened to structure.
 - 4. Field verify dimensions.
 - 5. Solder joints in shop-controlled conditions where possible.

3.02 PREPARATION

- A. Fabrication:
 - 1. Provide adequate laps to allow for material expansion and contraction.
 - 2. Exposed edges shall be turned back and hemmed 1/2".
 - 3. Solder joints shall be thoroughly cleaned with acetone to a degreased,

SHEET METAL FLASHING AND TRIM

SECTION 07 62 00

cleaned condition prior.

- B. Coordinate work with the schedules of other trades affected by this work.

3.03 INSTALLATION OR APPLICATION

- A. Sheet metal work in connection with roofs shall be set in a solid bed of approved sealant material.
- B. Fasteners:
 - 1. Wherever possible, use concealed clips or cleats in lieu of exposed fasteners.
 - 2. Fastener spacing shall not exceed 8", unless noted otherwise.
- C. Accurately form materials to fit together neatly and accurately to form an effective watertight seal.
 - 1. Materials shall fit together to form true, straight lines and angles.
- D. Counter flash corner joints and set in sealant as required to form watertight seams.
- E. Soldering:
 - 1. Pre-trim edges of sheet metal prior to soldering.
 - 2. Apply flux immediately prior to soldering to each surface.
 - 3. Apply soldering iron to material until thoroughly heated and the solder has been completely sweated through the full width of the seam.
 - 4. After soldering, all residual flux shall be removed with a solution of washing soda in water.
 - 5. In areas where water can accumulate, such as gutters, scuppers, and diverters, joints shall be soldered.
- F. Reglet and Flashing System:
 - 1. General:
 - a. Coordinate counter flashing at roof surfaces with roofing work to provide weathertight condition at roof terminations.
 - b. Isolate dissimilar materials to prevent electrolysis. Separate using bituminous coating.
 - c. Secure reglets and counter flashing using continuous cleats, clips, and fasteners, in accordance with product data, and as indicated on the Drawings.

SHEET METAL FLASHING AND TRIM
SECTION 07 62 00

2. Install reglets in accordance with manufacturer's product data, level, and true-to-line. Verify that through-wall counter flashing occurs at or above reglet locations.
 - a. Install reglets as walls are built.
 - b. Install with top of reglet a minimum of seven (7) inches above the high point of cant strip (adjacent roof).
 - c. Install reglets with one (1) inch factory-formed end lap and counter flashing with three (3) inch end lap.
3. Provide factory-fabricated corners at changes in direction.
4. Following installation of roofing, install counter flashing by snapping into reglet in accordance with manufacturer's product data. Overlap adjacent lengths six (6) inches, minimum, to allow for expansion and contraction.
5. Provide counterflashed expansion joints at 20'-0" on center.
6. Parapet caps, gutters, and other flashings exposed to normal view shall have factory applied color finish, over 24 ga galvalume.
 - a. Kynar 500 fluorocarbon paint system.
 - b. Color selected by Architect.

3.04 QUALITY CONTROL

- A. Field Testing:
 1. Running or standing water testing may be required of the work of this Section to demonstrate water tightness of work.
- B. Use full lengths of material to minimize the number of joints.
- C. Sheet metal and accessories shall be left free of dirt, grease, acids, or other compounds which may inhibit the proper bonding of paint finishes.

END OF SECTION

**ROOF ACCESSORIES
SECTION 07 72 00**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Roof hatches;
 - 3. Vent, electrical, and plumbing roof jacks
 - 4. Roof hatch safety railing.
 - 5. Associated accessories and hardware;
 - 6. Clean up.
- B. Related Sections:
 - 1. Section 06 10 00: Rough Carpentry
 - 2. Section 07 62 00: Sheet Metal Flashing and Trim
 - 3. Division 7: Roofing Systems
- C. References:
 - 1. SMACNA - Architectural Sheet Metal Manual.
 - 2. NRCA - National Roofing Contractors Association

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Submit copies of manufacturer's product specifications, installation instructions, and product recommendations.
- B. Samples or Mockups:
 - 1. At the request of the Architect, submit one (1) sample of proposed products for approval.
 - a. If approved, the sample may be incorporated into the work.
 - b. If not approved, sample will be returned to contractor.

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Unless otherwise noted, comply with the SMACNA Architectural Sheet Metal Manual.
 - 2. Roof hatches and safety railing shall meet CAL-OSHA requirements.

**ROOF ACCESSORIES
SECTION 07 72 00**

PART 2 PRODUCTS

2.01 PRODUCTS

- A. Manufacturers:
 - 1. Roof Hatches:
 - a. Bilco Company: #S-20 2'-6" x 3'-0";
 - b. Milcor: #M-1;
 - c. Dur-Red Products: #LH 2'-6" x 3'-0";
 - d. Or approved equal.
 - 2. Prefabricated Roof Jacks:
 - a. Orbit Industries, Inc. Series RJ
 - b. Or approved equal.
 - 3. Roof Hatch Safety Railing System
 - a. Bilco Company: Bil-guard 2.0 Model RL2-S
 - b. Milcor: MSTR-30-52 Saf-T-Rail
 - c. Dur-Red Products
 - d. Or approved equal.

2.02 MATERIALS

- A. Roof Hatches:
 - 1. Roof hatches shall be single leaf, with 14-gauge galvanized iron-welded construction integral-curb, double-wall type, with 22 gauge-insulated hatch door(s), unless noted otherwise.
 - a. Unit to have hold-open feature.
 - b. Unit shall have integral throat venting where noted on the drawings.
 - 1) Used in unconditioned Custodial areas with mop sinks.
 - c. Unit to have inside padlock provision.
 - d. Unit shall be shop-primed, ready for paint.
- B. Roof Jacks:
 - 1. Roof Jacks shall be 24 ga. galvanized sheet metal.
 - a. Orbit Industries, Inc., #RJ Series sized as required.
- C. Roof Hatch Safety Railing System:
 - 1. Safety Railing shall be of Aluminum rail construction with powder coat paint finish.
 - 2. System shall include standard self-closing and latching gate.
 - 3. Safety Railing shall attach directly to the roof hatch cap flashing.
 - 4. System shall be corrosion resistant and carry a 5-year warranty.

PART 3 EXECUTION

1.01 EXAMINATION

**ROOF ACCESSORIES
SECTION 07 72 00**

- A. Verify all required curbs, backing, and blocking prior to enclosing framing.
- B. Start of work shall be considered as acceptance of existing conditions.

1.02 INSTALLATION OR APPLICATION

- A. Install per the manufacturer's latest written recommendations.
- B. Roof jacks shall be installed in watershed fashion with the roof covering set in a complete bed of roof mastic. Top of roof jack shall be sealed to the pipe or conduit with a double layer of aluminum tape. Clean and degrease areas required for proper tape adhesion. All roof jacks exposed to view shall be painted.

1.03 CONDITION OF FINISHED WORK

- A. Completed installation shall be clean, neatly finished, with no visible imperfections.
- B. All work shall be watertight soldered connections.

END OF SECTION 07 72 00

JOINT SEALANTS
SECTION 07 92 00

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Building-related joint sealants;
 - 3. Joint primer and filler;
 - 4. Interior joint sealant required to prevent passage of moisture into wall assemblies or behind fixtures and built-in furnishings;
 - 5. Surface preparation;
 - 6. Application and curing;
 - 7. Clean up.
- B. Related Sections:
 - 1. Section 07 62 00: Sheet Metal Flashing and Trim
 - 2. Section 08 51 13: Aluminum Windows
- C. Performance Requirements:
 - 1. The completed system shall form a positive barrier against passage of moisture into interior wall assemblies or behind fixtures and from exterior to interior building areas.

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Manufacturer's Data:
 - a. Submit a complete material listing of items proposed to be installed under this Section.
 - b. Submit data to demonstrate that all materials meet or exceed the specified requirements.
 - c. Submit product specifications, installation instructions, and manufacturer's recommendations for the materials that will be installed.

**JOINT SEALANTS
SECTION 07 92 00**

1.03 QUALITY ASSURANCE

- A. Warranty:
 - 1. Provide a written guarantee to maintain sealant/caulking in a watertight condition for a minimum period of 2 years.
- B. Qualifications:
 - 1. Installer shall be thoroughly trained and experienced in the necessary skills required to perform this work.
- C. Delivery, Storage, and Handling:
 - 1. Deliver materials to the jobsite in original, unopened containers with labels intact.
 - 2. Store only under conditions recommended by the manufacturers.
 - 3. Remove and dispose of material that has exceeded the shelf life recommended by its manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General Purpose Building Sealant (window and door frames, plumbing fixtures, wet areas) (non-paintable):
 - 1. Silicone sealant meeting ASTM C920, Type S, Grade NS, Class 25, and Fed Spec. TT-S-001543:
 - a. Sonneborn Sonolastic Omniplus;
 - b. GE Silicones Construction 1200;
 - c. Dow-Corning 790;
 - d. Or approved equal.
- B. General Purpose Building Sealant (paintable):
 - 1. Latex sealant meeting ASTM C920, Type S, Grade NS, Class 25, and Fed Spec. TT-S-001543:
 - a. DAP Dynaflex 230;
 - b. Or approved equal.
 - 2. Silyl-terminated polyether sealant meeting ASTM C920, Type S, Grade NS, Class 25, and Fed Spec. TT-S-001543:
 - a. Sonneborn 150;
 - b. Or approved equal.

JOINT SEALANTS
SECTION 07 92 00

- C. Colors for each sealant shall be selected by the Architect from manufacturer's standard color range.
- D. Primers shall be non-staining and specifically recommended for the type of installation by their manufacturer.
- E. Backup materials shall be non-absorbent and non-staining, closed cell, and specifically recommended for the type of installation by their manufacturer.
- F. Bond prevention materials shall be recommended by the manufacturer for the sealant products used.
- G. Materials, not specifically described, but necessary to complete this work, shall be first quality.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed.
- B. Correct conditions detrimental to the proper completion of the work.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Concrete:
 - 1. Thoroughly clean surface.
 - 2. Sandblast or wire brush treated surfaces, if required, to obtain a clean, smooth surface.
 - 3. Remove all laitance and mortar from the joint cavity.
 - 4. Insert approved backup material in the joint cavity to the depth required.
 - 5. Surfaces shall be wiped clean and dry prior to application to insure proper adhesion.
 - 6. Where the possibility of joint filler staining adjacent areas or materials exists, mask joints prior to application.
 - 7. Do not remove masking tape before joints have been tooled, and initial cure of joint filler has taken place.
 - 8. Work stained due to failure of proper masking precautions will not be accepted.

3.03 INSTALLATION OR APPLICATION

- A. Installation of Backup Material:
 - 1. Compress the backup material 25% to 50%.

JOINT SEALANTS

SECTION 07 92 00

2. Avoid lengthwise stretching of the material.
3. Do not twist or braid backup stock.

B. Priming:

1. Apply the primer in strict compliance with the manufacturer's recommendations.

C. Bond Breaker Installation:

1. Install a bond breaker where recommended by the manufacturer of the sealant.

D. Installation of Sealants:

1. Comply with manufacturer's recommended width-to-height ratios.
2. Apply sealant under pressure to completely fill joints.
3. Completely mask joints where the appearance of sealant on adjacent surfaces would be objectionable.
4. Install the sealant in conformance with the manufacturer's recommendations.
5. Tool all joints to the profile shown, or as directed by Architect.
6. Joints shall be left smooth, uniform, and free of voids or air bubbles.

3.04 PROTECTION OR ADJUSTMENTS

- A. Protect the work and materials of all other trades.

3.05 CLEANING OR REPAIR

- A. Remove masking tape immediately after joints have been tooled and initial cure of joint filler has taken place.
- B. Clean adjacent surfaces.
- C. Use solvent or cleaning agent as recommended by the sealant manufacturer.

END OF SECTION 07 92 00

ACCESS DOORS AND FRAMES
SECTION 08 31 13

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Access doors;
 - 3. Accessories and associated hardware;
 - 4. Submittal preparation;
 - 5. Clean up.
- B. Related Sections:
 - 1. Section 06 10 00: Rough Carpentry
 - 2. Section 08 71 00: Door Hardware
 - 3. Section 09 21 16: Gypsum Board Assemblies
 - 4. Section 09 91 00: Painting

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Submit copies of the manufacturer's latest written installation instructions prior to beginning installation.

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Fire-rated doors shall bear a label from Underwriters Laboratory for Class B (1-1/2 hour) rating meeting CBC, IBCO, BOCA codes, and be CSFM recognized for up to two (2) hour rated walls.

PART 2 PRODUCTS

1.01 MANUFACTURERS

- A. J.L. Industries;
- B. Karp Associates, Inc.;
- C. Milcor;
- D. Larsens or
- E. Approved equal.

ACCESS DOORS AND FRAMES
SECTION 08 31 13

1.02 MATERIALS

- A. Doors shall be fabricated from 14-gauge minimum steel and shall be insulated with non-combustible filler.
- B. Door frames and flanges shall be 16-gauge minimum steel.
- C. Weld, fill, and grind smooth joints.

1.03 ACCESSORIES OR HARDWARE

- A. Mount door on 175 degree minimum swing hinges with removable pins.
- B. Milcor Retrofit Saf-T-Rail adjustable gated roof hatch safety rail system

1.04 KEYING OR SECURITY

- A. Doors in secure areas as Custodian rooms or Electrical equipment rooms shall have quarter-turn cam locks.
- B. All other access doors shall have cylinder lock. Key all access doors alike.

1.05 FINISH

- A. Doors shall receive a baked-on factory primer coat.
- B. Final finish shall be field-applied as specified in Section 09 91 00 Painting.

PART 3 EXECUTION

3.01 MANUFACTURERS

- A. Verify all required backing and blocking prior to enclosing framing.
- B. Verify sizes and locations of rough openings.
- C. Start of work shall be considered as acceptance of existing conditions.

3.02 MANUFACTURERS

- A. Install per the manufacturer's latest written recommendations.
- B. Install plumb, level and true-to-line.
- C. Fasten rigidly into place.

**ACCESS DOORS AND FRAMES
SECTION 08 31 13**

3.03 CONDITION OF FINISHED WORK

- A. Completed installation shall be clean, with no visible imperfections.

END OF SECTION 08 31 13

STOREFRONT AND ENTRANCE DOORS
SECTION 08 41 13

PART 1 GENERAL INFORMATION

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Aluminum storefront, related sections, aluminum column covers, and aluminum entrance doors;
 - 3. Furnishing, fabrication, delivery, and installation of materials for the work of this Section;
 - a. Aluminum tubes, channels, plates, reinforcing, and fasteners for storefront work and entrance doors.
 - b. Storefront sash, division and corner bars, sill and jamb trim, bulkheads, aluminum frame sections, and brake metal;
 - 4. Finish hardware for entrance doors under this Section;
 - 5. Caulking in connection with this work;
 - 6. Preparation of submittals including shop drawings and structural calculations;
 - 7. Clean up.
- B. Related Sections:
 - 1. Section 07 92 00: Joint Sealants
 - 2. Section 08 71 00: Door Hardware
 - 3. Section 08 81 00: Glass and Glazing

1.02 SUBMITTALS

- A. Shop Drawings or Layout Drawings:
 - 1. Submit copies of drawings of installation details for storefront and entrance units to Architect for approval.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Kawneer;
- B. US Aluminum Corp.;
- C. Or equal.

2.02 MATERIALS

- A. Storefront and Components:
 - 1. Quality Standard:
 - a. Kawneer Trifab VG 451T (1" glazing).
 - 1) 2" x 4-1/2" nominal dimension;
 - 2) Thermal break;
 - 3) Center Glazed;
 - (a) Front, Back or Multi-Plane Glazed when indicated on Drawings.

STOREFRONT AND ENTRANCE DOORS

SECTION 08 41 13

2. Aluminum:
 - a. Material Standard: Extruded Aluminum, ASTM B 221; 6063-T5 alloy and temper.
 - b. Member Wall Thickness: Each framing member shall provide structural strength to meet specified performance requirements.
 - c. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal, and in compliance with AA Aluminum Standards and Data.

B. Entrances and Components:

1. Quality Standard:
 - a. Kawneer Flushline Entrances
 - b. The door stile and rail face dimensions of the Flushline™ Entrance door will be as follows:

Door	Vertical Stile	Top Rail	Bottom Rail
Flushline™	5" (127 mm)	5" (127 mm)	5" (127 mm)
2. The door face sheet shall be aluminum.
 - a. Architectural quality aluminum sheet 0.090" (2.3 mm) thick plain unpatterned.
3. Vision lites, if required:
 - a. Aluminum-framed vision lite (AVL)
4. Glass for vision lites to be 1" (25.4 mm) insulated clear tempered glass.
5. Vision lite glazing shall be with foam glazing tape.

2.03 ACCESSORIES OR HARDWARE

A. Storefront and Components:

1. Fasteners: Where exposed, shall be Stainless Steel.
2. Gaskets: Glazing gaskets shall be extruded EPDM rubber.
3. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
4. Thermal Barrier:
 - a. Thermal break with a 1/4" separation consisting of a two-part chemically curing, high density polyurethane that is mechanically and adhesively joined to aluminum storefront sections.
 - 1) Thermal Break shall be designed in accordance with American Architectural Manufacturers Association (AAMA) TIR-A8, and tested in accordance with AAMA 505.
 - 2) Fenestration assembly shall have a maximum U-value of 0.55.

B. Entrances and Components:

1. Fasteners: Where exposed, shall be aluminum, stainless steel, or plated steel.

STOREFRONT AND ENTRANCE DOORS

SECTION 08 41 13

2. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
3. Entrance Hardware:
 - a. Furnish and install hardware per Section 08710 – Finish Hardware. Manufacturer's standard hardware shall be used as follows when not specified under Finish Hardware.
 - 1) Weather-stripping:
 - (a) Meeting stiles on pairs of doors shall be equipped with an adjustable astragal utilizing wool pile with polymeric fin.
 - (b) The door weathering on a single acting offset pivot or butt-hung door and frame (single or pairs) shall be comprised of a thermoplastic elastomer weathering on a tubular shape with a semi-rigid polymeric backing.
 - 2) Sill Sweep Strips: EPDM blade gasket sweep strip in an aluminum extrusion applied to the interior exposed surface of the bottom rail with concealed fasteners.
 - 3) Threshold: Extruded aluminum, one piece per door opening with ribbed surface.

2.04 FABRICATION

- A. Storefront System Fabrication:
 1. Fabricate components per manufacturer's installation instructions, and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
 2. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
 3. Prepare components to receive anchor devices. Fabricate anchors.
 4. Arrange fasteners and attachments to conceal from view.
- B. Entrance System Fabrication:
 1. Door corner construction shall consist of mechanical clip fastening, SIGMA-deep penetration plug welds and 1-1/8" long fillet welds inside and outside of all four corners. Glazing stops shall be hook-in type with EPDM glazing gaskets reinforced with non-stretchable cord.
 2. Accurately fit and secure joints and corners. Make joints hairline in appearance.
 3. Prepare components with internal reinforcement for door hardware.
 4. Arrange fasteners and attachments to conceal from view.

2.05 FINISH

- A. Exposed aluminum shall be given an Architectural Class II Clear Anodic Coating per AAMA 611 OR Dark Bronze No. 40 finish (ARCHITECT: CHOOSE ONE)
 1. #17 Clear anodized finish, unless otherwise noted.
 2. Minimum coating thickness 0.0007".

STOREFRONT AND ENTRANCE DOORS

SECTION 08 41 13

- B. Ferrous metal work shall be given a coat of Rust-Oleum #1386 gray primer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all required backing and blocking prior to enclosing framing.
- B. Verify framing or surfaces are acceptable prior to installing finish materials.
 - 1. Preparatory work is complete.
 - 2. Subsurface is plumb, straight, and true.
 - 3. Surface is securely fastened to structure.
 - 4. Verify all water-resistive barriers, flexible flashings, etc. are properly installed with proper watershed lapping prior to starting installation of frames.

3.02 INSTALLATION OR APPLICATION

- A. Storefront System:
 - 1. Fabricate setting blocks and spacer shims from neoprene or treated hardwood.
 - a. Material used for blocks and spacers must be compatible with type of compounds and sealant used and shall not cause staining or discoloration of the sealant or the frame.
 - 2. Install storefront systems plumb, level, and true-to-line, without warp or rack of frames with manufacturer's prescribed tolerances and installation instructions. Provide support and anchor in place.
 - a. Installation shall be designed to allow for natural expansion and contraction of glass and to counteract shocks and vibrations.
 - b. Dissimilar Materials: Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points.
 - c. Weathertight Construction: Install sill members and other members in a bed of sealant or with joint filler or gaskets, to provide weathertight construction. Coordinate installation with wall flashings and other components of construction.
 - 1) Refer to Section 07900 – Joint Sealants for installation requirements.
 - 2) Seal joints between metal and masonry.
 - 3. Glass: Refer to Section 08800 – Glass and Glazing.
 - a. Reference: ANSI Z97.1, CPSC 16 CFR 1201, and Glass Association of North America (GANA) Glazing Manual.
 - b. Clean the sealing surfaces at perimeter of glass and sealing surfaces.
 - 1) Use only approved solvents and cleaning agents recommended by the compound manufacturer.
 - c. Center glass in glazing rabbet to maintain recommended clearances at perimeter on all four sides.

STOREFRONT AND ENTRANCE DOORS
SECTION 08 41 13

- B. Entrance System:
1. General: Install entrance system in accordance with manufacturer's instructions and AAMA storefront and entrance guide specifications manual.
 - a. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
 - b. Provide alignment attachments and shims to permanently fasten system to building structure.
 - c. Align assembly plumb and level, free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.
 - d. Set thresholds in bed of mastic and secure.
 - e. Adjusting: Adjust operating hardware for smooth operation.

3.03 QUALITY CONTROL

- A. Tolerances:
1. Gaps around and between entrance doors shall not exceed 1/8 inch.

3.04 PROTECTION OR ADJUSTMENTS

- A. Protect installed product's finish surfaces from damage during construction. Protect aluminum storefront system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.
1. Damaged or discolored work shall be replaced without additional cost to the Owner.

3.05 CLEANING OR REPAIR

- A. Final Clean Up:
1. Clean installed products in accordance with manufacturer's instructions.
 - a. No abrasive or caustic agents shall be used.
 2. Repair cracks, scratches, and other defects.
 3. Remove construction debris from site and legally dispose of debris.

3.06 CONDITION OF FINISHED WORK

- A. Heads and sills of the same height shall line up with each other.
- B. No sandpaper marks, hammer marks, or blemishes will be allowed.
- C. Space around doors shall be uniform on both sides and top.
- D. Work shall be level, plumb, square, at proper elevations, and in alignment with other work.
- E. Corners of doors shall be accurately joined and fitted with a flush hairline joint.

END OF SECTION

INSULATED TRANSLUCENT PANEL SYSTEM

SECTION 08 45 23

PART 1 GENERAL INFORMATION

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. All material and labor required to deliver and install an insulated translucent panel system including the following:
 - a. Prefabricated insulated translucent panels.
 - b. Aluminum installation system.
 - 3. Submittal preparation;
 - 4. Clean up.
- B. Related Sections:
 - 2. Section 06 10 00: Rough Carpentry
 - 3. Section 07 92 00: Joint Sealants
 - 4. Section 08 81 00: Glass and Glazing

1.02 QUALITY ASSURANCE

- A. Manufacturer's and Erector's Qualifications:
 - 1. Insulated translucent panel system must be listed by the International Conference of Building Officials, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an approved agency; and the National Evaluation Service of the International Building Code.
 - 2. Quality control inspections and required testing shall be conducted at least once each year and shall include manufacturing facilities, insulated panel components, and production insulated panels for conformance with "Acceptance Criteria for Insulated Panels" as regulated by the ICBO-ES.
 - 3. Materials and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten (10) consecutive years and which can show evidence of these materials being satisfactorily used on at least six (6) projects of similar size, scope, and location within such a period. At least three (3) of the projects shall have been in successful use for ten (10) years or longer.
 - 4. Erection shall be by installer that has been in the business of erecting specified materials for at least five (5) consecutive years and can show evidence of satisfactory completion of projects of similar size, scope, and type.
- B. Performance Requirements: The manufacturer shall be responsible for the configuration and fabrication of the complete panel system.

1.03 SUBMITTALS

- A. Submit shop drawings and color samples in accordance with General Conditions.
 - 1. Shop drawings shall be submitted showing all components of the panel

INSULATED TRANSLUCENT PANEL SYSTEM

SECTION 08 45 23

system and their relationship and connections to adjacent materials.

- B. Test reports to be furnished by insulated panel system manufacturer. The manufacturer shall submit certified test reports made by an independent testing organization for each type and class of panel system. Reports shall verify that the material will meet all performance requirements of this specification. Previously completed test reports will be acceptable if for current manufacturer and indicative of products used on this project. Test reports required are:

1. ICC-ES Evaluation Report: ICC ESR-2464
2. Flame Spread and Smoke Developed (UL 723) – Submit UL Card;
3. Burn Extent (ASTM D-635);
4. Color Difference (ASTM D-2244);
5. Erosion Resistance (ASTM D-4060);
6. Impact Strength (UL 972);
7. Tensile Bond Strength (ASTM C-297 after aging by ASTM D-1037);
8. Shear Bond Strength (ASTM D-1002 after five (5) separate conditions);
9. Beam Bending Strength (ASTM E-72);
10. Insulation "U" Factor (NFRC-100);
11. NFRC Certification;
12. Condensation Resistance Factor (AAMA 1503.1);
13. Class 1 Fire Approval (FM 4411).

- C. Proof of regular, independent quality control monitoring under a nationally recognized building code review and listing program shall be submitted.

1.04 PRODUCT HANDLING

- A. Store translucent panels on the long edge, several inches above the ground, blocked and under cover to prevent warping in accordance with manufacturer's storage and handling instructions.

1.05 WARRANTY

- A. Submit manufacturer's one-year material and workmanship warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Kalwall Corporation;
- B. Or approved equal.

2.02 INSULATED TRANSLUCENT PANELS

- A. Translucent Facing:
1. Translucent faces shall be manufactured from glass fiber reinforced thermoset resins specifically for architectural use. Standard commercial grade fiberglass sheets or thermoplastic (e.g. polycarbonate, acrylic) plastic sheets will not be acceptable.
 2. Flammability:

INSULATED TRANSLUCENT PANEL SYSTEM
SECTION 08 45 23

- a. The interior face sheet shall be UL listed and have a flamespread rating no greater than 20 and smoke development no greater than 200 when tested in accordance with UL 723. Burn extent by ASTM D-635 shall be no greater than 1". Faces shall not deform, deflect, or drip when subjected to fire or flame, or delaminate when exposed to 300°F for 25 minutes per CBC.
- 3. Weatherability:
 - a. The full thickness of the exterior face shall not change color more than 3.0 CIE Units DELTA E by ASTM D-2244 after five (5) years outdoor South Florida weathering at 5 degrees facing south, determined by the average of at least three (3) white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
 - b. The exterior face shall have a permanent glass erosion barrier embedded beneath the surface to provide long-term resistance to reinforcing fiber exposure. Sacrificial surface films or coatings are not acceptable erosion barriers. Exterior face surface loss shall not exceed .7 mils and 40 mgs when tested in accordance with ASTM D-4060-90 employing CS17 abrasive wheels at a head load of 500 grams for 1000 cycles.
- 4. Appearance:
 - a. Exterior face sheets shall be smooth, .070" thick, and white in color. Interior face sheets shall be .045" thick and white in color. Faces shall not vary more than $\pm 10\%$ in thickness and shall be uniform in color.
- 5. Strength:
 - a. The exterior face sheet shall be uniform in strength, impenetrable by handheld pencil, and repel an impact equal to 70 foot pounds without fracture or tear when impacted by a 3-1/4" diameter, 5 lb. free-falling ball per UL 972. Tests relating to failure only at complete penetration, will not be adequate.
- B. Grid Core:
 - 1. Panels shall incorporate a thermally broken aluminum I-beam grid core of 6063-T6 or 6005-T5 with provisions for mechanical interlocking of mullion and perimeter. Width of I-beam shall be no less than 7/16". The I-beam grid shall be machined to tolerances of not greater than $\pm .002$ ".
 - 2. Panels shall withstand 1200°F fire for minimum one (1) hour without collapse or exterior flaming.
 - 3. Thermally broken panels shall have minimum Condensation Resistance Factor of 80 by AAMA 1503.1 measured on the grid frame line and minimum CRF of 90 for center of grid cell.
- C. Adhesive:
 - 1. The laminate adhesive shall be heat and pressure resin type engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Conference of Building Officials "Acceptance Criteria for Insulated Panel Adhesives".

INSULATED TRANSLUCENT PANEL SYSTEM

SECTION 08 45 23

2. Minimum tensile strength shall be 750 PSI when the panel assembly is tested by ASTM C-297 after two (2) exposures to six (6) cycles each of the aging conditions prescribed by ASTM D-1037.
 3. Minimum shear strength of the panel adhesive by ASTM D-1002 after exposure to five (5) separate conditions:
 - a. 50% Relative Humidity at 73° F: 540 PSI
 - b. 182° F: 100 PSI
 - c. Accelerated Aging by ASTM D-1037 at room temperature: 800 PSI
 - d. Accelerated Aging by ASTM D-1037 at 182° F: 250 PSI
 - e. 500-Hour Oxygen Bomb by ASTM D-572: 1400 PSI
- D. Panel Construction:
1. Panels shall have a thickness of 2-3/4" with a "U" factor by NFRC certified laboratory of 0.18.
 2. Translucent panels shall be a true panel of flat fiberglass sheets bonded to a grid core of mechanically interlocking (thermally broken) aluminum I-beams. Panels shall be laminated under a controlled process of heat and pressure, and deflect no more than 1.9" at 30 psf in 10' span without a supporting frame by ASTM E-72.
 3. Grid pattern shall be nominal 12" x 12" square.
 4. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
- E. Battens and Perimeter Closure System:
1. Closure system shall be extruded 6063-T6 and 6063-T5 aluminum clamp-tite screw type. Thermally broken perimeter system shall have a urethane bridge. Curved closure systems may be roll formed.
 2. All battens and perimeter closures to be supplied with 300 series stainless steel screws (excluding final fasteners to the building).
 3. Finish of all exposed aluminum shall be manufacturer's standard that meets the performance requirements of AAMA 2604. Color to be selected from manufacturer's standards.
- F. Flexible Sealing Tape:
1. Sealing tape shall be manufacturer's standard pre-applied to closure system at the factory under controlled conditions.

PART 3 EXECUTION

3.01 PREPARATION

- A. The general contractor shall prepare openings including isolating dissimilar materials from aluminum system, which may cause damage by electrolysis and shall provide temporary enclosures if required.

INSULATED TRANSLUCENT PANEL SYSTEM
SECTION 08 45 23

3.02 ERECTION

- A. The erector shall erect translucent panel system in strict accordance with approved shop drawings as supplied by manufacturer. Fastening and sealing shall be in strict accordance with manufacturer's shop drawings and installation instructions. All surfaces shall be cleaned before sealants are applied.
- B. After other trades have completed work on adjacent material, carefully inspect translucent panel installation and make adjustments necessary to ensure proper installation and weather-tight conditions.
- C. All staging, lifts, and hoists required for the complete insulated panel installation, including staging, etc., necessary for field measuring, shall be provided by, set up, and maintained by the general contractor.
- D. All fasteners to hold down panels to primary structures shall be spaced and sized so as to comply with supporting engineering calculations.

END OF SECTION

**DOOR HARDWARE
SECTION 08 71 00**

PART 1 GENERAL INFORMATION

1.01 SUMMARY

A. INCLUSIONS

1. Provisions set forth in Divisions 0 & 1;
2. Door Hardware.

B. Related Sections:

1. Section 06 20 0 Finish Carpentry
 - a. Finish Hardware Installation
2. Section 07 90 0 0 Joint Sealants
 - a. Exterior Thresholds.
3. Section 08 41 00 Entrances and Storefronts.

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere.

1. Windows.
2. Cabinets, including open wall shelving and locks.
3. Signs, except where scheduled.
4. Toilet accessories, including grab bars.
5. Installation.
6. Rough hardware.
7. Access doors and panels, except cylinders where detailed.
8. Corner Guards.

1.02 REFERENCES:

- A. Use date of standard in effect as of Bid date.
- B. American National Standards Institute – ANSI 156.18 – Materials and Finishes.
- C. ADA – Americans with Disabilities Act of 2010
- D. BHMA – Builders Hardware Manufacturers Association
- E. DHI – Door and Hardware Institute
- F. NFPA – National Fire Protection Association
 1. NFPA 80 – Fire Doors and Windows
 2. NFPA 101 – Life Safety Code
 3. NFPA 105 – Smoke and Draft Control Door Assemblies
- G. UL – Underwriters Laboratories
 1. UL10C – Fire Tests of Door Assemblies as amended to incorporate positive pressure testing.
 2. UL 305 – Panic Hardware
- H. WHI – Warnock Hersey Incorporated
- I. State of California Building Code, Chapter 11B.
- J. Local applicable codes

1.03 SUBMITTALS & SUBSTITUTIONS

- A. SUBMITTALS:** Submit copies of schedule per General Conditions. Organize vertically formatted schedule into "Hardware Sets" with index of doors and headings, indicating complete designations of every item required for each door or opening. Include following information:
1. Type, style, function, size, quantity and finish of hardware items.
 2. Use BHMA Finish codes per ANSI A156.18.
 3. Name, part number and manufacturer of each item.
 4. Fastenings and other pertinent information.
 5. Location of hardware set coordinated with floor plans and door schedule.
 6. Explanation of abbreviations, symbols, and codes contained in schedule.
 7. Mounting locations for hardware.

**DOOR HARDWARE
SECTION 08 71 00**

8. Door and frame sizes, materials and degrees of swing.
 9. List of manufacturers used and their nearest representative with address and phone number.
 10. Catalog cuts.
- B. Bid and submit manufacturer's updated/improved item if scheduled item is discontinued.
 - C. Make substitution requests in accordance with General Conditions. Include product data and indicate benefit to the Project. Furnish operating samples on request.
 - D. Furnish as-built/as-installed schedule with closeout documents, including keying schedule, wiring/riser diagrams, manufacturers' installation, adjustment and maintenance information, and supplier's final inspection report.

1.04 QUALITY ASSURANCE:

- A. Qualifications:
 1. Hardware supplier: direct factory contract supplier who employs a certified architectural hardware consultant (AHC), available at reasonable times during course of work for project hardware consultation to Owner, Architect and Contractor.
 - a) Responsible for detailing, scheduling and ordering of finish hardware.
- B. Hardware: New, free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.
- C. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.
- D. Furnish hardware items required to complete the work in accordance with specified performance level and design intent, complying with manufacturers' instructions.
 1. Where scheduled item is now obsolete, bid and furnish manufacturer's updated item at no additional cost to the project.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Delivery: coordinate delivery to appropriate locations (shop or field).
 1. Permanent keys and cores: secured delivery direct to Owner's representative.
- B. Acceptance at Site: Items individually packaged in manufacturers' original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.
- C. Storage: Provide securely locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, dust, excessive heat and cold, etc.

1.06 PROJECT CONDITIONS:

- A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical as the same operation and quality as type specified, subject to Architect's approval.
- B. Prior to submittal, carefully inspect existing conditions to verify finish hardware required to complete Work, including sizes, quantities, existing hardware scheduled for re-use, and sill condition material. If conflict between the specified/scheduled hardware and existing conditions, submit request for direction from Architect. Include date of jobsite visit in the submittal.

**DOOR HARDWARE
SECTION 08 71 00**

1. Submittals prepared without thorough jobsite visit by qualified hardware expert will be rejected as non-compliant.

1.07 SEQUENCING AND COORDINATION:

- A. Coordinate with concrete.
- B. Reinforce walls for wall-mounted hardware, including wall stops and stainless steel guard rails.
- C. Coordinate finish floor materials and floor-mounted hardware.
- D. Furnish manufacturer templates to door and frame fabricators.
 1. Ensure proper reinforcement in doors and frames to support machine screws for door closers.

1.08 WARRANTY:

- A. Part of respective manufacturers' regular terms of sale. Provide manufacturers' written warranties:
 1. Locksets: Three years.
 2. Closers: Thirty years.
 3. Other Hardware: Two years.

1.09 COMMISSIONING:

- A. Conduct these tests three weeks prior to request for certificate of substantial completion:
 1. Test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.

1.10 REGULATORY REQUIREMENTS:

- A. Locate latching hardware between 34" to 44" above the finished floor, per California Building Code, Section 1010.1.9.2 and 11B-404.2.7.
 1. Locate panic hardware between 36" to 44" above the finished floor.
- B. Handles, pull, latches, locks, other operating devices: readily openable without tight grasping, tight pinching, or twisting of the wrist to operate. California Building Code 1010.1.9.1 and 11B-309.4.
- C. Adjust doors to open with not more than 5.0 lbs pressure to open at exterior doors and 5.0 lbs at interior doors. As allowed per California Building Code, Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15 lbs.
- D. Adjust door closer sweep periods so that from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 12 degrees from the latch, measured to the landing side of the door, per California Building Code Section 11B-404.2.8.1.
- F. Smooth surfaces at bottom 10" of push sides of doors, facilitating push-open with wheelchair footrests, per California Building Code Section 11B-404.2.10.
- G. Door opening clear width no less than 32", measured from face of frame stop, or edge of inactive leaf of pair of doors, to door face with door opened to 90 degrees. Hardware projection not a factor in clear width if located above 34" and the hardware projects no more than 4". California Building Code Section 11B-404.2.3, 11B-404.2.4, and 1010.1.1.
- H. Door opening height shall not be less than 80 inches. Doors closers and door stops shall be permitted to be 78 inches minimum above the floor. California Building Code Section 11B-404.2.3 and 1010.1.1.1.
- I. Thresholds: floor or landing no more than 1/2" below the top of the threshold of the doorway. Change in level between 1/4" and 1/2": beveled to slope no greater than 1:2 (50 percent slope). California Building Code Section 11B-404.2.5.

**DOOR HARDWARE
SECTION 08 71 00**

- J. Floor stops: Do not locate in path of travel. Locate no more than 4" from walls.
- K. Pairs of doors: limit swing of one leaf to 90 degrees to protect persons reading wall-mounted tactile signage.
- L. New Buildings on a K-12 Public School campus shall be provided with locks which allow the doors to classrooms and any other room with an occupant load of five or more persons to be locked from the inside. Locks shall conform to the specification and requirements of Section 1010.1.11. Exceptions include doors that are normally locked from the outside, relocatable moved within the same campus, and reconstruction projects.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. Manufacturers and their abbreviations used in this schedule:

IVE	H. B. Ives
LCN	LCN Closers
BES	Best Lock Co.
SCH	Schlage Lock Company
ZER	Zero International

2.02 HINGING METHODS:

- A. Note: drawings typically depict doors at 90 degrees, doors will actually swing to maximum allowable. Use wide-throw conventional or continuous hinges as needed to allow door to stand parallel to wall for true 180-degree opening..
- B. Continuous Hinges:
 - 1. Geared-type aluminum at exteriors.
 - a. Heavy-duty, extra-bearing units for doors over 3 foot, 5 inches in width.
 - b. Heavy-duty, extra-bearing units for doors with panic hardware or fire exit devices.
 - c. Use wide-throw units where needed for maximum degree of swing, advise architect if commonly available hinges are insufficient.

2.03 LOCKSETS AND LATCHSETS:

- A. Mortise Locksets and Latchsets: as scheduled.
 - 1. Chassis: cold-rolled steel, handing field-changeable without disassembly.
 - 2. Latchbolts: 3/4 inch throw stainless steel anti-friction type.
 - 3. Lever Trim: through-bolted, accessible design, cast lever or solid extruded bar type levers as scheduled. Filled hollow tube design unacceptable.
 - a. Spindles: security design independent breakaway. Breakage of outside lever does not allow access to inside lever's hubworks to gain wrongful entry.
 - 4. Strikes: 16 gage curved steel, bronze or brass with 1 inch deep box construction, lips of sufficient length to clear trim and protect clothing.
 - 5. Scheduled Lock Series and Design: Schlage L series, 06A design.
 - 6. Certifications:
 - a. ANSI A156.13, 1994, Grade 1 Operational, Grade 1 Security.
 - b. ANSI/ASTM F476-84 Grade 31 UL Listed.
 - 7. Comply with CBC Section 11B-309.4.

**DOOR HARDWARE
SECTION 08 71 00**

2.04 CLOSERS

A. Surface Closers:

1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body. Double heat-treated pinion shaft, single piece forged piston, chrome-silicon steel spring.
2. ISO 2000 certified. Units stamped with date-of-manufacture code.
3. Independent lab-tested 10,000,000 cycles.
4. Non-sized and adjustable. Place closers inside building, stairs and rooms.
5. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
6. Opening pressure: Exterior doors 5 lb. max., interior doors 5 lb. max., the authority having jurisdiction may increase the opening force for fire-rated doors, not to exceed 15lbs max, per CBC 11B-404.2.9.
7. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
8. Extra-duty arms (EDA) at exterior doors scheduled with parallel arm units. EDA arms: rigid main and forearm, reinforced elbow.
9. Exterior door closers: tested to 100 hours of ASTM B117 salt spray test, furnish data on request.
10. Exterior doors do not require seasonal adjustments in temperatures from 120 degrees F to -30 degrees F, furnish data on request.
11. Non-flaming fluid, will not fuel door or floor covering fires.
12. Pressure Relief Valves (PRV): unsafe, not permitted.
13. Door closers shall be adjusted so that from the open position of 70 degrees, the door shall move to the closed position in 1.5 seconds minimum.

2.05 OTHER HARDWARE

- A. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.
- B. Door Stops: Provide stops to protect walls, casework or other hardware.
1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where floor type cannot be used, provide wall type. If neither can be used, provide overhead type.
 2. Locate overhead stops for maximum possible opening. Consult with Owner for furniture locations. Minimum: 90deg stop / 95deg deadstop. Note degree of opening in submittal.
- C. Thresholds: As scheduled and per details. Comply with CBC Section 11B-404.2.5. Substitute products: certify that the products equal or exceed specified material's thickness. Proposed substitutions: submit for approval.
1. Exteriors: Seal perimeter to exclude water and vermin. Use Dow Corning 795 Silicone or approved equal. Non-ferrous 1/4inch fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors (SS/FHSL).
 2. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.
- D. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHSL) may be

**DOOR HARDWARE
SECTION 08 71 00**

slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.

- E. Through-bolts: Do not use. Coordinate with wood doors; ensure provision of proper blocking to support wood screws for mounting panic hardware and door closers. Coordinate with metal doors and frames; ensure provision of proper reinforcement to support machine screws for mounting panic hardware and door closers.

2.06 FINISH:

- A. Generally BHMA 626 Satin Chromium.
 - 1. Areas using BHMA 626 to have push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise noted.
- B. Door closers: factory powder coated to match other hardware, unless otherwise noted.
- C. Aluminum items: match predominant adjacent material. Seals to coordinate with frame color.

2.07 KEYING REQUIREMENTS:

- A. Key System: existing Best small format interchangeable core. For estimate use factory GMK charge. Initiate and conduct meeting(s) with Owner to determine system structure and keybow styles, furnish Owner's written approval of the system.
 - 1. Construction keying: furnish keyed-alike temporary cores plus 10 operating keys. Temporary cores and keys remain property of hardware supplier.
- B. Interchangeable Cores: 7-pin solid brass construction.
- C. Permanent cores: furnish factory-keyed.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS:

- A. Experienced craftsperson with a resume of successful projects. Can readily differentiate between number 2 and number 3 phillips-drive screws and screwdrivers. Can readily differentiate between #10-24 machine screws and drywall screws, and can explain correct usages of these items.

3.02 PREPARATION:

- A. Ensure that walls and frames are square and plumb before hardware installation.
- B. Locate hardware per SDI-100 and applicable building, fire, life-safety, accessibility, and security codes.
 - 1. Notify Architect of any code conflicts before ordering material.
 - 2. Locate levers, key cylinders, t-turn pieces, touchbars and other operable portions of latching hardware between 34 inches to 44 inches above the finished floor, per CBC Section 11B-404.2.7.
 - 3. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.
- C. Overhead stops: before installing, determine proposed locations of furniture items, fixtures, and other items to be protected by the overhead stop's action.
- D. Existing frames and doors scheduled to receive new hardware: carefully remove existing hardware, tag and bag, and turn over to Owner.
 - 1. Metal doors/frames: Weld or fasten with screws: filler pieces in existing hardware cut-outs and mortises not scheduled for re-use by new hardware. Leave surfaces smooth - - no applied patches.

**DOOR HARDWARE
SECTION 08 71 00**

2. Remove unused existing floor closers, fill empty floor closer cavities with concrete.

3.03 INSTALLATION

- A. Install hardware per manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation. Remove and reinstall or replace work deemed defective by Architect.
 1. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc; fasten hardware over and through these seals. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
 2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
 3. Use manufacturers' fasteners furnished with hardware items, or submit Request for Substitution with Architect.
 4. Replace fasteners damaged by power-driven tools.
- B. Locate floor stops no more than 4 inches from walls and not within paths of travel. See paragraph 2.2 regarding hinge widths, door should be well clear of point of wall reveal. Point of door contact no closer to the hinge edge than half the door width. Where situation is questionable or difficult, contact Architect for direction.
- C. Locate overhead stops for minimum 90 degrees and maximum allowable degree of swing.
- D. Drawings typically depict doors at 90 degrees, doors will swing to maximum allowable. Install door closers to maximum allowable swing in conjunction with door stops.

3.04 ADJUSTING

- A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.
 1. Hardware damaged by improper installation or adjustment methods to be repaired or replaced to Owner's satisfaction.
 2. Adjust doors to fully latch with no more than 1 pound of pressure.

3.05 DEMONSTRATION:

- A. Demonstrate hardware systems, including adjustment and maintenance procedures.

3.06 PROTECTION/CLEANING:

- A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
- B. Clean adjacent wall, frame and door surfaces soiled from installation/reinstallation process.

**DOOR HARDWARE
SECTION 08 71 00**

3.07 SCHEDULE OF FINISH HARDWARE

A. See door schedule in drawings for hardware set assignments.

HW SET: 01

1	EA	CONTINUOUS HINGE	112HD	628	IVE
1	EA	CLASSROOM LOCK	LV9071BDC 06A	626	SCH
2	EA		PERMANENT CORE	626	BES
1	EA	SURFACE CLOSER	4111 H EDA X 62G	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	SECURITY FLOOR STOP	FS18S	BLK	IVE
1	EA	DOOR SWEEP	39A	AL	ZER
1	EA	THRESHOLD	545A MSLA-10	AL	ZER

PERIMETER SEALS BY DOOR MANUFACTURER

END OF SECTION

**GLASS AND GLAZING
SECTION 08 81 00**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1.
 - 2. Glass and glazing.
 - 3. Glass and glazing of wood and metal doors.
 - 4. All metal stop molds for fixed glass.
 - a. Except in hollow metal doors.
 - 5. Caulking in connection with this work.
 - 6. Submittal preparation.
 - 7. Clean up.
- B. Related Sections:
 - 1. Section 06 10 00: Rough Carpentry
 - 2. Section 08 41 13: Aluminum-Framed Entrances and Storefronts
 - 3. Section 08 51 13: Aluminum Windows

1.02 SUBMITTALS

- A. Product and Material Test Data:
 - 1. Submit copies of product and material test data of materials intended for use in this work to Architect for approval prior to beginning installation.
- B. Samples or Mockups:
 - 1. Upon request, submit one 4"x4" sample of materials intended for use in this work for approval by Architect.
- C. Shop Drawings:
 - 1. Submit copies of shop drawings to Architect for approval prior to beginning installation.
 - a. Include full size installation details.
- D. Certificates:
 - 1. Submit three signed certificates to Architect verifying that glass and glazing was installed per manufacturer's recommendations.

GLASS AND GLAZING

SECTION 08 81 00

1.03 QUALITY ASSURANCE

A. Regulatory Compliance:

1. Fire-rated glass shall comply with the requirements of the California Building Code (CBC) and Division of the State Architect (DSA) including, but not limited to, the following:

Note: Fire-rated glass specified is intended to meet or exceed CBC and/or DSA requirements:

- a. CBC Section 716.6 - Fire Protection Rated Glazing:
 - 1) Fire window assemblies in rated walls shall be protected by fixed glazing listed and labeled or marked for fire protection rating complying with CBC Table 716.6.
- b. CBC Section 716.2 - Fire Resistance Rated Glazing:
 - 1) Glazing materials in fire resistant rated wall assemblies shall be qualified by tests in accordance with ASTM E-119 or UL 263, and they shall be labeled for the required fire protection rating and installed in accordance with their listing. Glazing in fire door assemblies and in fire window assemblies subject to human impact in hazardous locations shall comply with Section 2406.2.
- c. CBC Section 2406.1 - Human Impact Loads:
 - 1) Individual glazed areas in hazardous locations, including glazing used in fire assemblies shall pass the test requirements of CPSC 16 CFR Part 1201, or CBC Table 2406.2(2).

B. Conformance:

1. Meet flatness requirements of ASTM C1048-12.
2. Lock-strip gaskets shall conform to ASTM C542-05.
3. Float glass shall meet ASTM C1036-11.
4. Glass strength shall meet or exceed ASTM E-1300-12.
5. Tempered glazing shall have a visible manufacturer's etched identification quality mark on each pane per C.B.C. Section 2406.3.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials in accordance with the manufacturer's recommendations.**
- B. Label each piece of glass.**
1. Indicate name of the manufacturer and the grade.

**GLASS AND GLAZING
SECTION 08 81 00**

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Non-Rated Glass:
 - 1. Clear, tinted, reflective, and obscured:
 - a. PPG Industries;
 - b. Oldcastle.
 - c. Or approved equal.
- B. Fire-Rated Glass:
 - 1. Fire rated glass for rated door and window assemblies:
 - a. SAFTIFIRST
 - b. TGP;
 - c. Or approved equal.

2.02 MATERIALS

- A. Polished Plate Glass:
 - 1. 1/4" thick float, clear annealed.
- B. Tempered Polished Plate Glass:
 - 1. Conform to Fed. Spec. DD-G-451a.
- C. Double Pane Glazing (1" insulated glazing Low E unit): Visual light transmission of 35%, Solar Heat Gain Coefficient (SHGC) of the glazing assembly shall be 0.24 or less:
 - 1. Exterior Glazing, including exterior doors:
 - a. Polished Plate Glass PPG Solargray with Solarban 60 on airspace side. Visual light transmission of 35%, Solar Heat Gain Coefficient (SHGC) when measured at the center of the glazing assembly shall be 0.24 or less.
 - 1) Tempered or non-tempered as indicated on Drawings.
 - 2. Air Space shall be 1/2" sealed.
 - 3. Interior Glazing:
 - a. Polished 1/4" Clear Float Plate Glass.
 - 1) Tempered or non-tempered as indicated on Drawings.
 - 4. Perimeter Seal:
 - a. Butyl primary seal on each side of metal spacer with structural adhesive grade silicone secondary seal.
 - 1) Tempered or non-tempered as indicated on Drawings.

**GLASS AND GLAZING
SECTION 08 81 00**

D. Fire-Rated Glass:

1. Properties:
 - a. Surface Finish:
 - 1) Premium (polished).
 - b. Thickness: 1-1/8"
 - c. Approximate visible light transmission:
 - 1) 85 percent minimum.
 - d. Fire Rating:
 - 1) 60 minutes minimum.
 - a) Fire rating listed and tested by Intertek Testing (WHI) or Underwriters Laboratory (UL) for fire rating scheduled at opening locations in Drawings, when tested in accordance with 2016 CBC Chapter 35, ASTM E-119, ASTM 1996-14.
 - b) Positive Pressure Test:
 - (1) Glass must pass UL 10C, 2016 CBC 716.6.1, and NFPA 257 or UL 9.
 - e. Impact Safety Rating: 2016 CBC 2406.2 - Table 2406.2(1) and CPSC 16CFR1202 (Category I and II).
 - f. Labeling:
 - 1) Permanently label each lite of glass with laboratory logo (WHI and/or UL), product and manufacturer's name, rating, and safety specifications. Lite frame shall not obstruct vision of the label (bug).
 - 2) Comply with 2016 CBC 2406.3.
2. Glazing Compound:
 - a. Glazing Tape:
 - 1) Closed cell polyvinyl chloride (PVC) foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent. Glass panels that exceed 1,393 sq. inches for 90-minute ratings must be glazed with fire-rated glazing tape supplied by manufacturer.
 - b. Silicone Sealant:
 - 1) One-part neutral curing silicone, medium modulus sealant, Type S; Grade NS; Class 25 with additional movement capability of 50 percent in both extension and compression (total 100 percent); Use (Exposure) NT; Uses (Substrates) G, A, and O as applicable.
 - a) Acceptable Products:
 - (1) Dow Corning 795 - Dow Corning Corp.
 - (2) Siliglaze-II 2800 - General Electric Co.
 - (3) Spectrum 2 - Tremco, Inc.
 - c. Setting Blocks:
 - 1) Hardwood; thickness of glass by 4 inches by 3/16" thick or Neoprene, EPDM, or silicone; tested for compatibility with glazing compound; of 70 to 90 Shore A hardness.

GLASS AND GLAZING
SECTION 08 81 00

- 3. Cleaners, Primers, and Sealers:
 - a. Type recommended by manufacturer of glass and gaskets.
- E. Exterior Door Glazing:
 - 1. 1/4" tempered float plate with gray tint to match exterior glazing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Field verify required sizes.

3.02 INSTALLATION OR APPLICATION

- A. Install caulking per manufacturer's recommendations.
- B. Immediately remove any acid or cement-containing products which may come into contact with glass or glazing.

3.03 CONDITION OF FINISHED WORK

- A. Glass and glazing shall be free of blemishes, scratches, pits, or bubbles.
- B. Glazing beads shall be seated properly and tightly.
- C. Caulking shall be installed smoothly and uniformly.
- D. Glass and glazing shall be clean, free of grease, dirt, and foreign materials, and shall be streak free.

END OF SECTION 08 81 00

GYPSUM BOARD ASSEMBLIES
SECTION 09 21 16

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1.
 - 2. Gypsum drywall.
 - 3. Gypsum board substrates for vinyl wallcoverings, tackboards, tackable corkboards
 - 4. Taping and accessories.
 - 5. Texture finish where indicated.
 - 6. Labor, materials, tools, and equipment.
 - 7. Submittal preparation.
 - 8. Clean up.
- B. Related Sections:
 - 1. Section 06 10 00: Rough Carpentry
 - 2. Section 26 05 00: Basic Electrical Materials and Methods
- C. Performance Requirements:
 - 1. Provide solid smooth surface when additional finish material is applied over gypsum drywall.
 - 2. Installations shall meet the requirements for fire ratings where specified.

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Submit product description data for all proposed products or materials for review and acceptance by Architect prior to start of work.

QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. CBC Chapter 25.
- B. Warranty:
 - 1. One (1) -Year per General Conditions.
- C. Environmental Requirements:
 - 1. Maintain temperatures, relative humidity, and other environmental conditions within manufacturer's suggested limits.

GYPSUM BOARD ASSEMBLIES
SECTION 09 21 16

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Gypsum Wallboard:
 - 1. US Gypsum Co.;
 - 2. Gold Bond;
 - 3. Georgia-Pacific
 - 4. Other approved equal.
- B. Accessories:
 - 1. Milcor;
 - 2. Superior;
 - 3. US Gypsum;
 - 4. Other approved equal.
- C. Texture Finish:
 - 1. US Gypsum;
 - 2. Other approved equal.

2.02 MATERIALS

- A. Gypsum Wall Board:
 - 1. Regular wall board; 5/8" Type "X" conforming to ASTM C1396, unless noted otherwise.
 - 2. High performance interior panels; 5/8" Georgia-Pacific DensArmor Plus High Performance Interior Panels where called for on drawings. Conform to ASTM C1658 & ASTM 1177.
 - 3. High Impact wall board;
 - 4. High abuse wall board;
 - 5. Water resistant wall board;
- B. Typical Trim and Accessories:
 - 1. 90 deg. outside corner bead: No-Coat by Drywall Systems International
 - 2. 90 deg. inside corner bead: No-Coat by Drywall Systems International
 - 3. Control joint: USG # 093
 - 4. Angle trim: No-Coat Ultraflex 450 by Drywall Systems International
 - 5. Channel trim: USG 700A
 - 6. Misc. trim: USG 200A, 200B, 401, 402 & 071B
- C. Screws:
 - 1. Designed for gypsum wallboard installation.
 - 2. Comply with UBC Standard 47-05.
- D. Nails:
 - 1. Annular ring-shank nails conforming to ASTM C514 per CBC Table no. 2506.2

GYPSUM BOARD ASSEMBLIES
SECTION 09 21 16

- E. Staples:
 - 1. Flattened 16 gauge galvanized wire with 1-1/8" legs.
- F. Joint Tape:
 - 1. US Gypsum Beadex Drywall Joint Tape
 - 2. USG Beadex drywall joint tape-paper
 - 3. USG Perf-a-Tape, self-adhesive fiberglass tape
- G. Joint Compounds:
 - 1. USG Sheetrock Durabond Taping Joint compound
 - 2. USG Sheetrock Topping Joint Compound

2.03 ACCESSORIES OR HARDWARE

- A. As required for proper installation.
- B. As required on drawings.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Handling, storage, and installation of the materials in accordance with the manufacturer's latest written requirements.

3.02 SEQUENCING AND SCHEDULING

- A. Coordinate location and installation of blocking and nailers required for the work of this Section.

3.03 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's latest written recommendations.
- B. Comply with California Building Code Section 2508 and Table 2508.1
- C. Additional Requirements:
 - 1. All vertical joints shall be positioned over a structural member.
 - 2. Set screw or nail heads slightly for the cement, but do not break paper finish.
 - a. Top with smooth coat of joint compound.
 - 3. Set joints with USG Perf-a-Tape and joint compound.
 - a. During hot, dry conditions use USG Durabond Taping Joint Compound or equal.
 - b. Knock-down high areas and finish with a coat of topping compound.

GYPSUM BOARD ASSEMBLIES

SECTION 09 21 16

- c. Taping may be omitted when gypsum board is used as a backing for tackable wallboard on interior wall (non-building envelope), non-rated assemblies only.
- 4. Use the largest sheet size possible to avoid excessive joints.
- 5. Horizontal surfaces shall be installed using type S or W screws at 12" on center maximum, unless noted otherwise. Install long side of sheets perpendicular to studs or joist.
- 6. Stagger all joints.
- 7. Do not use "score and knockout" method to cut openings.
- 8. Staples may only be used to secure trim accessories.
 - a. Fasten at 6" on center.

3.04 TEXTURE FINISH

A. Surface Preparation:

- 1. All surfaces, including joint compound applications, filling or patching treatments shall be dry, clean, and sound.
- 2. Remove any water-soluble materials from surface.
- 3. Dull or roughen any glossy surfaces.
- 4. Prime metal surfaces with a rust-inhibitive primer.
- 5. Fill and seal any exposed wood surfaces.

B. Surface Preparation:

- 1. Apply materials to blend uniformly and cover fully without starved spots or other evidence of thin application.
- 2. Provide uniform texture without application patterns.
- 3. Remove any texture droppings or overspray from wall, windows, and floor, leaving room clean for following trades.

C. Texture Finish Schedule:

- 4. Surface treatment and finish materials as required for the following textures:
 - a. Wall Texture (Refer to Gypsum Association # GA-214):
 - 1) Toilet Rooms and Kitchens to receive paint finish:
 - a) GA Level 5;
 - 2) All Other Rooms to receive paint finish:
 - a) GA Level 4;
 - 3) Areas to receive 1/4" corkboard:
 - a) GA Level 3;
 - 4) Areas to receive 1/2" tackboard:
 - a) GA Level 2; except- remove ridges
 - b) Fire rated walls shall have a minimum Level 3 or as required by rated assembly.
 - 5) Areas to receive vinyl wallcovering:
 - a) GA Level 4;

GYPSUM BOARD ASSEMBLIES
SECTION 09 21 16

- b. Ceiling Texture:
 - 1) Toilet Rooms and Kitchens:
 - a) GA Level 5;
 - b) Or approved equal.
 - 2) All Other Rooms:
 - a) GA Level 4;
 - b) Or approved equal.

3.05 QUALITY CONTROL

- A. Inspections:
 - 1. Inspector of Record
 - 2. Architect of Record
- B. Coordination:
 - 1. Meet with subsequent contractors whose work will follow to assure acceptance of substrate finish.
 - a. No additional cost for substrate preparation will be accepted by owner.

3.06 CLEANING OR REPAIR

- A. Keep premises clean during the progress of the work.
- B. Thoroughly clean-up work and adjacent areas upon completion of the work.
 - 1. Sweep areas clean.
 - 2. Remove tools, excess materials, and debris from site.

END OF SECTION

ACOUSTICAL CEILINGS
SECTION 09 51 00

PART 1 GENERAL

1.01 SUMMARY

A. Inclusions:

1. Provisions set forth in Divisions 0 and 1;
2. Suspended ceilings system;
3. Acoustical panels;
 - a. Lay-in panels.
4. Touch-up repairs;
5. Labor, materials, tools, and equipment;
6. Preparation of submittals;
7. Clean up.

B. Related Sections:

1. Section 06 10 00:	Rough Carpentry
2. Section 09 21 16:	Gypsum Board Assemblies
3. Section 23 30 00:	Heating, Ventilation and Air Conditioning
4. Section 26 51 00:	Interior Lighting

C. System Description:

1. System 1:
 - a. Metal ceiling grid system with lay-in acoustical panel.

1.02 SUBMITTALS

A. Product or Material Data:

1. System 1 and 2:
 - a. Submit product description and test and installation data for all proposed products or materials for review and acceptance by Architect prior to start of work.
 - 1) Metal ceiling grid system test must include the following for both main runners and cross runners:
 - a) Axial tension strength.
 - b) Ultimate compressive strength.
 - c) Ultimate load capacity.
 - d) Ultimate load capacity of splices, intersections, and joints.
 - 2) Ultimate capacity of all materials and connections must exceed 180 pounds.

ACOUSTICAL CEILINGS
SECTION 09 51 00

B. Samples or Mockups:

1. Submit a complete set of color selection samples of proposed materials for color selection by Architect prior to ordering materials.

C. Extra Stock:

1. Provide 2% extra ceiling tiles and wood fiber planks.

1.03 QUALITY ASSURANCE

A. Regulatory Compliance:

1. Materials must meet the standard set by the State of California for environmental protection and hazardous material content.
2. Comply with all requirements of Division of State Architect (DSA).
 - a. DSA Interpretation of Regulations (IR 25-2.13, *Revised 11/09/17*)
 - b. Qualified ICC-ER/ESR reports of submitted systems.

B. Qualifications:

1. Work to be performed by experienced, skilled craftsperson trained in this type of work.
2. Installer must be approved by the manufacturer to install the products covered under this Section of the specifications.

C. Environmental Requirements:

1. Contractor shall ensure that temperatures, relative humidity, and other environmental conditions for material storage, handling, and installation are maintained within the manufacturer's suggested limits.
 - a. System 1:
 - 1) Do not install ceiling panels until building is closed in and HVAC system is operational.
 - 2) Locate materials onsite at least 24 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.
 - 3) Maintain the following conditions in areas where acoustical materials are to be installed 24 hours before, during, and after installation.
 - 4) Relative Humidity: 65 - 75%.
 - 5) Uniform Temperature: 55 - 70 degrees F.
2. Provide adequate lighting for proper installation of materials.
3. Provide adequate ventilation for proper installation of materials.

D. Building to be dry and have reached average prevailing relative humidity of locality.

ACOUSTICAL CEILINGS
SECTION 09 51 00

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Suspension System:
 - 1. Chicago Metallic;
 - 2. Donn;
 - 3. Armstrong World Industries.
 - 4. Substitutions must demonstrate structural equivalency and must be submitted as a no cost change order and must be approved by the Division of the State Architect, Structural Safety Section, and the Structural Engineer of Record.
- B. Acoustical Tiles and Panels:
 - 1. Armstrong Ceilings;
 - 2. USG;
 - 3. Or approved equal.

2.02 MATERIALS

- A. Suspension System (System 1):
 - 1. Comply with ASTM C635, and DSA IR 25-5 latest revision.
 - 2. DSA acceptance in accordance with DSA publication IR A-5.
 - a. Heavy duty, main = CM #200, cross = CM #1214;
 - b. Heavy duty, main = Donn #DX26, cross = Donn #DX424;
 - c. Heavy duty, main = Donn #DX26, cross = Donn #DX216;
 - d. Heavy duty, main = Armstrong #7301, cross = Armstrong #XL-7320;
 - e. DSA-approved equal.
 - 3. Grid shall be exposed "t" bar type.
 - 4. Wall attachment angles shall be 2" wide.
 - 5. Exposed surfaces shall have a white baked-on vinyl or enamel finish.
- B. Acoustical Panels (System 1):
 - 1. 24" x 48" x 5/8" thick lay-in fiber board panels.
 - a. Pattern to be random fissured.
 - b. Flame spread rating of less than 25.
 - c. Smoke development of less than 450.
 - d. Acceptable products:
 - 1) Armstrong - Cortega;
 - 2) USG - Omni Fissured;
 - 3) Or approved equal.

ACOUSTICAL CEILINGS
SECTION 09 51 00

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces scheduled to receive suspended or directly attached acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of work.
- B. Do not proceed with installation of ceiling system until unacceptable conditions are corrected.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Handling, storage, and application of the materials covered under this Section of the specifications shall be performed in accordance with the manufacturer's latest written requirements.
- B. Materials shall be delivered to the site in original unopened containers showing the brand name and product identification number.
- C. Rejected materials shall be immediately removed from the site.

3.03 SEQUENCING AND SCHEDULING

- A. Sequence work to avoid potential damage from other trades.

3.04 INSTALLATION OR APPLICATION

- A. Suspended T-Bar System:
 - 1. Installation shall be in accordance with the manufacturer's latest written recommendations, drawings, and details, except where superseded by DSA requirements and the drawings, see typical installation notes below.
 - 2. Layout shall be as indicated on the drawing if shown.
 - a. Main runners shall be on 4 foot centers.
 - b. Cross runners shall be on 2 foot centers, unless noted otherwise.
 - 3. Install in a level, symmetrical, even pattern, unless shown otherwise.
 - a. Edge tiles shall be of uniform width, unless shown otherwise.
 - 4. Grid joints shall be tight and flush.
 - 5. Wall angles shall be secured firmly to the wall with a minimum 1 1/2" screw penetration into stud or blocking.
 - 6. Tiles shall be cut to fit neatly and snugly into "t" bar grid.
 - 7. Field tegularize all cut and edge tiles.
 - 8. See Typical Suspended Ceiling Notes below. Installation shall conform to DSA Interpretation of Regulations #IR 25-5.

ACOUSTICAL CEILINGS
SECTION 09 51 00

3.05 CLEANING OR REPAIR

- A. Keep premises clean during the progress of the work.
- B. Thoroughly clean up work and adjacent areas upon completion of the work.
 - 1. Sweep areas clean.
 - 2. Remove tools, excess materials, and debris from site.
- C. Replace all tiles or accessories damaged or stained during the course of this work.

3.06 TYPICAL SUSPENDED CEILING INSTALLATION NOTES:

- A. The following notes will be acceptable in plans and specifications for ceiling systems whose total weight, including air conditioning grilles and light fixtures, does not exceed four (4) psf. Heavier systems and those supporting lateral loads from partitions, will require special design details.
- B. #12 gauge (min.) hanger wires shall be 0.106 inches in diameter conforming to ASTM A641. #12 gauge wire shall be soft annealed, galvanized steel wire with a class 1 coating.
- C. #12 gauge wire may be used for up to and including 4'-0" x 4'-0" grid spacing and shall be attached to main runners.
- D. Provide #12 gauge hanger wires at the ends of all main and cross runners within eight inches (8") of the support or within one-fourth (1/4) of the length of the end tee, whichever is least, for the perimeter of the ceiling area. Perimeter wires are not required when the length of the end tee is 8" or less.
- E. Provide trapeze or other supplementary support members at obstructions to typical hanger spacing. Provide additional hangers, struts, or braces as required at all ceiling breaks, soffits, or discontinuous areas. Hanger wires that are more than 1 (horizontal) in 6 (vertical) out of plumb are to have counter sloping wires.
- F. Ceiling grid members shall be attached to two (2) adjacent walls per ASCE 7-05, Section 13.5.6.2(b). Ceiling grid members shall be at least 3/4" clear of other walls. If walls run diagonally to ceiling grid system runners, one end of main and cross runners should be free, and a minimum of 3/4" clear of wall.
- G. The width of the perimeter supporting closure angle shall be a minimum of 2".
- H. At the perimeter of the ceiling area where main or cross runners are not connected to the adjacent wall, provide interconnection between the runners at

ACOUSTICAL CEILINGS

SECTION 09 51 00

the free end to prevent lateral spreading. A metal strut or a 16 gauge wire with a positive mechanical connection to the runner may be used. Where the perpendicular distance from the wall to the first parallel runner is 12" or less, this interlock is not required.

- I. Expansion joints shall be provided in the ceiling at intersections of corridors and at junctions of corridors with lobbies or similar areas.
- J. Seismic separation joints shall be placed in ceiling areas over 2500 sq. ft. to divide the ceiling into areas not exceeding 2500 sq. ft. Alternatively, structural analysis shall be performed to demonstrate compliance with ASCE 7-05, Section 13.5.6.2.2 (d).
- K. Provide lateral-force bracing assemblies consisting of a compression strut and four (4) #12 gauge splayed bracing wires oriented 90 degrees from each other per the drawings and at the following minimum spacing:
 - 1. For school buildings, place bracing assemblies at a spacing not more than 12' by 12' on center.
 - 2. For Essential Services Buildings, place bracing assemblies not more than 8' by 12' on center.
 - 3. Provide bracing assemblies at locations not more than one half (1/2) the spacing given above, from each perimeter wall and at the edge of any change in elevation of the ceiling.
 - 4. The slope of these wires shall not exceed 45 degrees from the plane of the ceiling and shall be taut. Splices in bracing wires are not to be permitted without special DSA approval.
 - 5. Compression struts shall have a maximum slenderness ratio (kL/R) of 200 and shall not be more than 1 (horizontal) and 6 (vertical) out of plumb.
- L. Suspended acoustical ceiling systems with a ceiling area of 144 square feet or less, and fire-rated suspended acoustical ceiling systems with a ceiling area of 96 square feet or less, surrounded by walls which connect directly to the structure above, do not require lateral-force bracing assemblies when attached to two adjacent walls.
- M. Penetrations through the ceiling for sprinkler heads and other similar devices that are not integrally tied to the ceiling system in the lateral direction, shall have a 2" oversized ring, sleeve, or adaptor through the ceiling tile to allow free movement of 1" in all horizontal directions. Alternatively, swing joints may be provided per ASCE 7-05, Section 13.5.6.2.2(e).
- N. Fasten #12 hanger wires with not less than three (3) tight turns. Fasten #10 or #12 bracing wires with four (4) tight turns. Make all tight turns within a distance of 1½" inches. Hanger or bracing wire anchors to the structure should be installed in

ACOUSTICAL CEILINGS

SECTION 09 51 00

such a manner that the direction of the wire aligns as closely as possible with the direction of the wire.

1. Note: Wire turns made by machine where both strands have been deformed or bent in wrapping can waive the 1½" requirement, but the number of turns should be maintained, and be as tight as possible.
- O. Separate all ceiling hanging and bracing wires at least six inches (6") from all unbraced ducts, pipes, conduit, etc.
- P. When drilled-in concrete anchors or shot-in anchors are used in reinforced concrete for hanger wires, 1 out of 10 must be field tested for 200 lbs. in tension. When drilled-in concrete anchors are used for bracing wires, 1 out of 2 wire/anchor assemblies must be field tested for 440 lbs. in tension in the direction of the wire. Shot-in anchors in concrete are not permitted for bracing wires.
1. Note: drilled-in or shot-in anchors require special DSA approval when used in prestressed concrete.
- Q. Attach all light fixtures and ceiling-mounted air terminals to the ceiling grid runners to resist a horizontal force equal to the weight of the fixtures. Screws or approved fasteners are required.
- R. Flush or recessed light fixtures and air terminals, weighing less than 56 lbs., and mechanical terminals and services, weighing less than 20 lbs., may be supported directly on the runners of a heavy duty grid system but, in addition, they must have a minimum of two 12 gauge slack safety wires attached to the fixture at diagonal corners and anchored to the structure above. All 4' x 4' light fixtures must have slack safety wires at each corner.
1. All flush or recessed light fixtures and air terminals or services weighing 56 lbs. or more must be independently supported by not less than four (4) taut 12 gauge wires each attached to the fixture and to the structure above, regardless of the type of ceiling grid system used.
 2. The four (4) taut #12 gauge wires, including their attachment to the structure above, must be capable of supporting four (4) times the weight of the unit.
 3. Support surface-mounted light fixtures by at least two positive devices which surround the ceiling runner, and which are each supported from the structure above by a #12 gauge wire. Spring clips or clamps that connect only to the runner are not acceptable.
 - a. Provide additional supports when light fixtures are 8'-0" or longer. Maximum spacing between supports shall not exceed 8'-0".

ACOUSTICAL CEILINGS
SECTION 09 51 00

- S. Support pendant-mounted light fixtures directly from the structure above with hanger wires or cables passing through each pendant hanger and capable of supporting two (2) times the weight of the fixture. A bracing assembly per drawing details, and note 11 above, is required where the pendant hanger penetrates the ceiling. Special details are required to attach the pendant hanger to the bracing assembly to transmit horizontal forces.
 - 1. If the pendant-mounted light fixture is directly and independently braced below the ceiling, i.e. aircraft cables to the walls, then brace assembly is not required above the ceiling. See DSA publication IR 16-9 for additional requirements for pendant-mounted fixtures.
- T. Metal panel and panels weighing more than 1/2 #/sq. ft., other than mineral fiberboard, shall be positively attached to the ceiling suspension runners.
- U. Where gypsum board or other ceiling finishes are attached to the framing, see specific details on the drawings for the vertical hanger wire and lateral bracing wire support connections to the framing.

3.07 REQUIREMENTS FOR MODERNIZATIONS AND ALTERATIONS TO EXISTING SUSPENDED CEILING SYSTEMS"

- A. The entire ceiling system shall be upgraded to meet the current requirements of the CBC and DSA IR 25-5 if any portion of the grid system is cut or altered.
- B. Unless called for on the drawings, the replacement of existing ceiling panels with panels of the same materials and light fixtures of the same size and weight does not require an upgrade to the ceiling grid and suspension system.

END OF SECTION

SIGNAGE
SECTION 10 14 00

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1.
 - 2. Signage.
 - 3. Accessories and associated hardware.
 - 4. Submittal preparation.
 - 5. Clean up.
- B. Related Sections:
 - 1. Section 09 21 16: Gypsum Board Assemblies
 - 2. Section 09 91 13: Exterior Painting
- C. References:
 - 1. CBSC Part 1, Title 24, 4-317 (c).

1.02 SUBMITTALS

- A. Samples or Mockups:
 - 1. Submit one (1) sample of the manufacturer's complete color range to the Architect for color selection purposes prior to ordering material.
- B. Shop Drawings or Layout Drawings:
 - 1. Submit copies of shop drawings to the Architect for review prior to beginning fabrication.

1.03 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. All signage shall conform to California Building Code (CBC) Section 11B-703.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Plastic Room ID, Directional and Restroom Signs:
 - 1. Mohawk Sign Systems;
 - a. Series 200A
 - 2. Allenite;
 - a. Series 1500
 - 3. Or approved equal.
- B. Individual Cast Letters:

SIGNAGE
SECTION 10 14 00

1. Matthews International Corporation;
2. Or approved equal.

2.02 MATERIALS

A. Plastic Room Identification and Directional Signage:

1. Signs shall be sand-carved 1/8" thick phenolic ES plastic laminate.
 - a. Background shall be light suede finish, color as selected by Architect.
 - b. Characters shall be gloss smooth finish, color as selected by Architect.
2. Signage shall conform to California Code of Regulations, Title 24, Part 2, 2019 CBC Section 11B-703.
 - a. Characters shall be raised 1/32" (0.794 mm) minimum and shall be Sans Serif upper case characters or simple Serif type accompanied by Grade 2 Braille (see part b below).
 - 1) Character size: Raised characters shall be a minimum 5/8" (15.9 mm) and a maximum of 2 inches (51 mm) high.
 - 2) Finish and contrast: Characters and their background shall have a non-glare finish. Characters shall contrast with their background with either light characters on a dark background or dark characters on a light background. (CBC 11B-703.5.1).
 - 3) Proportions: Characters shall be selected from fonts where the width of the upper-case "O" is between 60% and 110% of the height of the upper-case letter "T". (CBC 11B-703.5.4). Minimum character heights shall be per CBC Table 11B-703.5.5. Character stroke thickness shall be 10% minimum and 20 % maximum of the height of the character (CBC Section 11B-703.5.7). See details on drawings for heights on room identification signs.
 - 4) Text shall also be written in California Grade No. 2 Braille per CBC Sections 703.3 & 703.4, and Table 703.3.1 and Figure 11B-703.3.1.
 - 5) Pictograms shall comply with CBC Section 11B-703.6.

B. Restroom Door Signage:

1. Identification symbols on doorways to sanitary facilities shall be as follows:
 - a. Men/Boys sanitary facilities to be identified by an equilateral triangle ¼ inch thick (6.4 mm) with edges 12 inches (305 mm) long and a vertex pointing upward, centered on the door between 58" and 60" A.F.F., and the color is to be distinctly different from the color and contrast of the door. (CBC Section 11B-703.7.2.6.1)
 - b. Women/Girls sanitary facilities to be identified by a circle ¼ inch thick, 12 inches in diameter, centered on the door between 58" and 60" A.F.F. and the color is to be distinctly different from the color and contrast of the door (CBC Section 11B-703.7.2.6.2).
 - c. Unisex sanitary facilities to be identified by a circle ¼ inch thick 12 inches in diameter with a ¼ inch thick triangle superimposed on the circle and within the 12 inch (305 mm) diameter.

SIGNAGE

SECTION 10 14 00

- 1) Color of triangle to contrast with circle, and the circle shall contrast with color of the door. . (CBC Section 11B-703.7.2.6.3)
2. Signs shall be 1/4" thick solid acrylic plastic base with 1/8" thick characters chemically welded to base.
3. Mechanically attach signage with tamper-resistant sex bolts.
4. The verbal description to be placed directly below the pictogram.
5. The minimum outside dimension of the pictogram to be 6 inches (152 mm) in height.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all required backing and blocking prior to enclosing framing.
- B. Start of work shall be considered as acceptance of existing conditions.

3.02 INSTALLATION OR APPLICATION

- A. Install signage per Drawings.
 1. Anchorage of signs shall be set in full bed of clear silicone adhesive with tamper resistant wood screws into solid blocking, or concrete screws into block/bricks.
 2. Where signs are mounted on windows; signs shall be set in a full bed of clear silicone adhesive.
- B. Installation of room identification signage shall comply with accessibility guidelines per CBC Chapter 11B.
 1. Room identification signs shall be installed at + 60" height to the bottom of the top line of text and centered 9" from the strike of door, unless noted otherwise. Reference CBC Sec. 11B-703.4.1.

3.03 SCHEDULES

- A. Room Identification and Miscellaneous Signs:
 1. Refer to Signage Schedule on Drawings.

END OF SECTION 10 14 00

**SITE SIGNAGE
SECTION 10 14 56**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Site Signage;
 - 3. Accessories and associated hardware;
 - 4. Concrete footings and poles required for mounting signage;
 - 5. Submittal preparation;
 - 6. Clean up.
- B. Related Sections:
 - 1. Section 32 12 16: Asphaltic Concrete Paving
 - 2. Section 32 13 13: Concrete Site Paving
 - 3. Section 32 17 00: Paving Accessories and Striping
 - 4. Section 32 17 26: Tactile Warning Surfacing

1.02 SUBMITTALS

- A. Shop Drawings or Layout Drawings:
 - 1. Submit copies of shop drawings to the Architect for review prior to beginning fabrication.

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Signs shall comply with the requirements of the California Building Code (CBC) and Division of the State Architect (DSA) Access Compliance Section.
 - 2. All pass gates with a 48" or less wide gate leaf shall comply with exit door and general door requirements and be supplied with lever hardware. (landings, hardware, kick-plate, strike edge clearance, clear opening).

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Signs:
 - 1. ASI Sign Systems;
 - 2. Or approved equal.

**SITE SIGNAGE
SECTION 10 14 56**

2.02 MATERIALS

- A. Metal Signage:
 - 1. Use 1/16-inch thick galvanized steel with porcelain enamel graphics and letters.
 - a. Secure with masonry anchor screws where applicable.
- B. Mounting Post:
 - 1. 2-3/8" outside diameter schedule 40 galvanized post.
- C. Concrete:
 - 1. By volume, one-part Type II Portland cement to 2-1/2 parts sand, to 3-1/2 parts aggregate.
 - a. Use only enough water to properly hydrate the mix and produce a maximum 4" slump.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Start of work shall be considered as acceptance of existing conditions.

3.02 INSTALLATION OR APPLICATION

- A. Install per Drawings and the manufacturer's latest written recommendations, unless shown otherwise.
- B. Mounting Post:
 - 1. Set in concrete footings as shown on the Drawings.
 - a. Minimum footing size: 10" diameter x 24" deep, set post or sleeve 3" from bottom of footing.
 - b. Set post in 2-1/2" nominal sleeve (2.469 inside diameter) when signage is in walk or paved areas. Sleeve shall protrude above top of concrete 1" and have 5/16" diameter galvanized tamper resistance sex bolts through pipe and sleeve. Sleeve shall be embedded in concrete to 3" from bottom of footing.
 - c. Add post extensions to existing post where required to achieve a minimum of 6'-8" clearance to bottom of signage.
 - d. Where existing paving is sawcut to accept footing- apply asphalt sealant in all overcuts.
 - 2. Post shall be set not more than 1/4" out of plumb over the height of the post.
- C. Concrete:
 - 1. Use only enough water to properly hydrate the mix and produce a maximum 4" slump.
 - 2. Remove loose soil from bottom of footings and tamp earth tight before pouring concrete.

**SITE SIGNAGE
SECTION 10 14 56**

3.03 SCHEDULES

- A. Parking and Traffic Control Signs:
 - 1. Accessible Parking Authorization Signage (Detail D3/A-501):
 - a. Unauthorized Vehicles towed away.
 - 2. Accessible Parking Stall Signage (Detail C6/A-501):
 - a. International Symbol of Accessibility.
 - b. Van Accessible Sign where shown.

END OF SECTION

**PLUMBING
SECTION 22 00 00**

PART 1 GENERAL

A. SCOPE.

1. Work Included. Provide all labor, materials and services necessary for complete, lawful and operating systems as shown or noted on the drawings or as specified here. The work includes, but is not necessarily limited to, the following:
 - a) Extension of cold water to roof mounted hose bibbs.
 - b) A complete system of natural gas fuel piping including gas pressure regulators, and connections to all gas utilizing equipment.
 - c) Condensate drains from air conditioning and refrigeration units.
 - d) Furnishing, mounting and final connections to fixtures and equipment as shown or scheduled on the plumbing and architectural drawings that is part of any system listed above.
 - e) Final connections to equipment provided in other sections of these specifications or indicated as furnished by owner and installed by the contractor.
 - f) Demolition of all plumbing fixtures, equipment and piping systems indicated or required to be removed or modified.

B. CODES AND STANDARDS

2. All work and materials shall conform with current rules and regulations of applicable codes. Nothing in these Drawings or Specifications is to be construed to permit work not conforming to these codes. Should the Drawings or Specifications call for material or methods of construction of a higher quality or standard than required by these codes, the Drawings and Specifications shall govern.
3. Applicable codes and standards shall include but are not necessarily limited to:

**PLUMBING
SECTION 22 00 00**

- a) California Code Of Regulations:
 - 1) Title 8, Industrial Relations
 - 2) Title 17, Public Health
 - 3) Title 19, Public Safety
 - 4) Title 21, Public Works
 - 5) Title 24, Energy Regulations
- b) California Building Code.
- c) California Mechanical Code
- d) California Plumbing Code
- e) Local Codes and Ordinances
- f) American Gas Association (AGA)
- g) Air Moving and Conditioning Association (AMCA)
- h) American National Standards Institute (ANSI)
- i) Air Conditioning and Refrigeration Institute (ARI)
- j) American Society of Heating, Refrigerating, and Air Conditioning Engineers
- k) American Society of Mechanical Engineers (ASME)
- l) American Society for Testing and Materials (ASTM)
- m) American Water Works Association (AWWA)
- n) Cast Iron Soil Pipe Institute (CISPI)
- o) National Electrical Code (NEC)
- p) National Electrical Manufacturers Association (NEMA)

PLUMBING
SECTION 22 00 00

- q) National Fire Protection Association (NFPA)
- r) National Sanitation Foundation (NSF)
- s) Occupational Safety and Health Act (OSHA)
- t) Plumbing and Drainage Institute (PDI)
- u) Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- v) Underwriters' Laboratory (UL)
- w) Requirements of local, state, and federal enforcing authorities codes and amendments to preceding codes shall be applicable to work performed under this specification.
- x) Americans with Disabilities Act. Accessibility Guidelines for Buildings and Facilities. (ADAAG).

C. COORDINATION OF WORK

1. Before starting any work, thoroughly examine all existing and newly completed underlying and adjoining work and conditions upon which the installation of this work is in any way dependent for the workmanship required by the Contract Documents. Report to the Architect and Engineer in writing any and all conditions which might adversely affect this work and limit ability to perform the required workmanship.
2. Layout of materials, equipment and systems is generally diagrammatic unless specifically dimensioned. The actual locations of all materials, piping, ductwork, fixtures, equipment, supports, etc., shall be carefully planned, prior to installation of any work, to avoid all interference's with each other, or with structural, electrical or architectural elements. Verify the proper voltage and phase of all equipment with the electrical plans. All conflicts shall be called to the attention of the Engineer prior to the installation of any work or the ordering of any equipment.
3. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the mechanical, electrical, structural, architectural drawings and field conditions that could affect the work to be performed and arrange such

PLUMBING
SECTION 22 00 00

work accordingly. Provide the required piping and ductwork offsets, fittings, and accessories to meet such conditions.

4. Spaces provided in the design of the building shall be utilized and the work shall be kept within walls or furring lines established on the drawings. Any discrepancy between Architectural or Mechanical drawings with respect to wall or furring locations and dimensions shall be brought to the Architect's attention for resolution before proceeding with installation.
5. Any work which is done as an addition, expansion, or remodel of an existing system shall be compatible with that system.

D. MANUFACTURER'S RECOMMENDATIONS

1. All material, equipment, and devices, etc., shall be installed in a manner meeting approval of the manufacturer of the particular item. The Contractor shall make himself available of all installation manuals, brochures, and procedures that the manufacturer issues for the equipment and material. Contractor shall be held responsible for all installations contrary to the manufacturer's recommendations. Contractor shall make all necessary changes and revisions to achieve such compliance.

E. GUARANTEE

1. Guarantee shall be in accordance with the General Conditions. These Specifications may extend the period of the guarantee for certain items. Where such extensions are called for, or where items are normally provided with guarantee periods in excess of that called for in the General Conditions, the certificate of guarantee shall be furnished to the Owner.

F. QUIETNESS

1. Piping of all types, ductwork, and equipment shall be arranged and supported so that the vibration is at a minimum and is not transmitted to the building structure.

G. DAMAGES BY LEAKS

1. The Contractor shall be responsible for damages caused by leaks in the temporary or permanent piping or mechanical systems prior to completion of work and during the period of the guarantee.

H. SUBMITTALS

PLUMBING
SECTION 22 00 00

1. Shop Drawings. Within 30 days of contract award, the Contractor shall submit six copies of shop drawings for all materials, equipment, etc., proposed for use on this project. Material or equipment shall not be ordered or installed until written review is processed by the Engineer. Any item omitted from the submittal shall be provided as specified without substitution. All shop drawings must comply with the following:
 - a) Shop drawings are required for all material and equipment items and shall include manufacturer's name and catalog numbers, dimensions, capacities, performance curves, and all other characteristics and accessories as listed in the contract documents. Descriptive literature shall be current manufacturer's brochures and submittal sheets.
 - b) All shop drawings shall be submitted at one time in a three hole binder with title sheet including Project Title, Architect, Engineer, Contractor, table of contents, and indexed tabs dividing each group of materials or item of equipment. All items shall be identified by the specification paragraph number for which they are proposed. All equipment shall also be identified by the mark number as indicated on drawings. Submittals shall bear the stamp of certification by the Contractor as evidence that the Contract Documents (Specifications and Drawings) have been thoroughly checked.
 - c) All capacities, characteristics, and accessories called for in the specifications or on the drawings shall be high-lighted, circled or underlined on the shop drawings. Data must be complete enough to permit detailed comparison of every significant characteristic which is specified, scheduled or detailed.
1. Review. Submittals will be reviewed for general conformance with the design concept, but this review does not guarantee quantity shown, nor does it supersede the responsibility of the Contractor to provide all materials, equipment and installation in accordance with the drawings and specifications. The Contractor shall agree that shop drawing submittals processed by the Engineer are not Change Orders; that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.
 - a) If deviations, discrepancies or conflicts between shop drawings and design drawings and specifications are discovered either prior to or after

PLUMBING
SECTION 22 00 00

shop drawing submittals are processed by the Engineer, the design drawings and specifications shall control and shall be followed.

Submittals for products and equipment offered as an alternate to that specified will require, if accepted by the Engineer, resubmission of the Title 24 Energy Compliance Calculations if the specified product or equipment was included within the scope of the approved calculations on file with the reviewing authority. The cost of preparing resubmission will be the responsibility of the Contractor.

I. OPENINGS, CUTTING AND PATCHING

1. The locations and dimensions for openings through walls, floors, ceilings, foundations, footings, etc. required to accomplish the work under this Specification Division shall be provided under this Division. Except as noted below, the actual openings and the required cutting and patching shall be provided by other Divisions. Coring through existing concrete or masonry walls, floors or asphaltic concrete required to accomplish the work under this Specification Division shall be provided under this Division. Restoration of all surfaces shall be provided by other Divisions. Cutting or coring shall not impair the strength of the structure. Any damage resulting from this work shall be repaired at the Contractor's expense to the satisfaction of the Architect and Engineer.

J. DEMOLITION

1. Existing equipment, ducts, piping, valves, fittings, devices, etc., requiring removal shall be removed and delivered to the Owner at a location on the job site to be determined by the Owner. Those items determined by the Owner to be of no value shall become the property of the Contractor and shall be removed from the job site by the Contractor at the Contractor's expense.
2. Existing piping, ducts, and services, etc., requiring capping or plugging shall be capped or plugged below floors, behind walls, above ceilings or above roof unless otherwise noted.

K. HANGERS AND SUPPORTS.

1. Provide all hangers and supports for the proper installation of equipment and materials under this Section of the Specification.
2. Any structural element required to properly hang or support piping, ducts, or equipment, etc., provided under this Specification Section and not shown on the Architectural or Structural Drawings shall be provided under this Specification Section.

**PLUMBING
SECTION 22 00 00**

L. CONTINUITY OF SERVICES

1. All existing services and systems shall be maintained except for short intervals when connections are to be made. The contractor shall be responsible for any interruptions of services and shall repair damage done to any existing service caused by the work.
2. If utilities not indicated on the drawings are uncovered during excavation, the Contractor shall notify the architect immediately for further instructions.

M. FLASHING

- a) Whenever any part of the Mechanical System(s) must penetrate the roof or outside wall, the openings shall be flashed and counter-flashed absolutely water tight with minimum 22 gauge galvanized sheet metal, prime coated. Flashing aprons shall extend not less than eight inches (8") from the duct, pipe, or supporting member in all directions unless detailed otherwise. All penetrations shall be flashed following the procedures of the National Roofing Contractor's Association.

N. PAINTING

- a) Paint all black iron supports, hangers, anchors, etc., and all uninsulated black iron pipe work installed in weather exposed locations with one coat of rust resisting primer.

O. ACCESS DOORS AND PANELS

- a) Provide access doors as required where equipment, piping, valves, ductwork, etc. are not otherwise accessible. Access doors shall match the wall or ceiling finish and fire rating as indicated on the Architectural drawings or as required to match wall construction. 16-gauge steel frame and 14-gauge steel panel with paintable finish, except in ceramic tile, where panel shall be 16-gauge stainless steel with satin finish. Continuous hinge. Screwdriver latch. Deliver panels to the General Contractor for installation. Provide Zurn Z-1460-4 for square doors and Z-1460-5 for rectangular doors, Karp, or equivalent. Unless otherwise noted , the minimum sizes shall be as follows:

1 valve up to 1-1/2"	12"x12"
1 valve up to 3"	16"x16"
Fire damper, VAV box, coil	16"x16"

**PLUMBING
SECTION 22 00 00**

P. DEFINITIONS

- a) Provide. The term "provide" as used in these specifications or on the Drawing shall mean furnish and install.
- b) Piping. The term "piping" as used in these Specifications or on the Drawings shall mean all pipe, fittings, nipples, valves, unions, hangers, and thermal insulation, etc., as may be required for a complete and functional system.
- c) Ductwork. The terms "duct" or "ductwork" as used in these Specifications or on the drawings shall mean all ducts, fittings, joints, dampers, hangers, and thermal insulation, etc., and other devices as may be required to make a complete and functional system.
- d) Wiring. The term "wiring" shall include the provision of all necessary products which are required for a complete installation and shall include products such as conduit, electrical boxes, connections, transformers, relays and switches.

Q. PROJECT CLOSE-OUT

- a) Record Drawings
Provide in accordance with general conditions of the specifications.

PART 2 MATERIALS

A. General

- 2. All material shall be in conformance with current specifications of American Society of Testing Materials (ASTM) and CBC Section 1118 B.

B. Piping

1. Domestic Cold Water

b) Inside Building, Above Grade or Slab

- 1) Type "L" hard drawn copper tubing with wrought copper solder joint fittings, NIBCO, ANACONDA, or acceptable equivalent. Joints shall be made with 95.5 solder, such as Silavoy Streamline 122, Silvabrite 100 or acceptable "lead free" equivalent. Pipe to be reamed to full bore,

PLUMBING
SECTION 22 00 00

de-burred, and joint area cleaned with a Trisodiumphosphate solution prior to joining.

- 2) Where allowed under local and state building codes: Mechanically formed copper Tee connection is acceptable as follows: Form extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze and prepare joints per above. T-drill system.

c) Outside Building

- 1) Schedule 40 galvanized steel with galvanized malleable iron banded 150 lb. fittings. Pipe shall be protected as specified elsewhere in this section.
- 2) Type "K" hard drawn. All else per copper specification above.

2. Condensate Drains

- a) Standard weight, galvanized steel, Schedule 40 with galvanized malleable iron banded 150 lb. fittings, or type "L" hard drawn copper tubing with wrought copper solder joint fittings. All changes in direction of condensate drain shall be accomplished with plugged tees. Drains shall be extended as indicated on drawings or to nearest acceptable fixture or vent if not indicated.

C. Valves

1. General

- a) Manufacturer's model numbers are listed to complete description. Equivalent models of Crane, Grinnell, Nibco, or Stockham are acceptable. Use ball valves for 1-1/2" and smaller domestic hot and cold water, and gate valves for 2" and larger size.

2. Gate Valve

- a) 2" and Smaller. All bronze, Malleable iron hand wheel, Rising stem, Union bonnet, Wedge disc, 200 psi WOG, Stockham B-105.

PLUMBING
SECTION 22 00 00

- b) 2-1/2" and Larger. Iron body, bronze mounted, Non-rising stem, Wedge disc, 200 psi WOG, Flanged or AWWA hub end as applicable. Stockham G-612. Underground valves shall have square operating nut. Provide one operating "T" handle for underground valves.

3. Check Valves

- a) 2" and Smaller. All bronze swing check, regrinding. 200 psi WOG. Stockham B-319.
- b) 2-1/2" and Larger. Swing check, iron body, brass mounted seats, Class 125. Stockham G-931.

4. Ball Valve

- a) Bronze body, cap, stem, disk and ball. Screwed connection. Lever handle TFE seat. O-ring seals. 600 psi WOG. Consolidated Brass "Apollo", Grinnell,

5. Plug Valves

- a) Lubricated plug cock. Cast iron or semi-steel body and plug. 200 PSI WOG. Flanged. Wrench handle. U.L. listed for gas distribution. Resun R-1430 Walworth 1700 F. Ball valves with U.L. listing for gas distribution and equivalent or higher pressure rating may be substituted for 2" and smaller plug valves. Apollo, Watts.

D. Insulation

1. General

- a) All insulation shall comply with the requirements per the California Building energy Efficiency standards, Title 24. Refer to Table 120.3-A, Pipe Insulation Thickness
- b) All insulation jackets and lapseal adhesives shall be tested as a composite product in accordance with UBC Standard No. 42-1 and shall have a flame spread of not more than 25 and a smoke developed rating of not more than 50.

PLUMBING
SECTION 22 00 00

- c) All domestic hot water piping, fittings and accessories shall be insulated. All circulating piping shall be insulated. Cold water piping in ventilated attic shall be insulated.

2. Interior Piping, Fittings and Valves

- a) Shall be insulated with 1" thick Fiberglass ASJ/SSL U.L. rated pipe insulation through 1" diameter pipe, 1-1/2" thick for 1-1/4" diameter pipe and above. Fittings shall be hard molded plastic flush. Do not insulate flanges or valves unless water temperature exceeds 140°F or the piping is exposed to weather.

3. Piping Exposed to Weather or View

- a) All piping and fittings exposed to weather shall have, in addition to the above-described insulation, aluminum jacketing. 0.016" thickness for straight pipe. 0.024" thickness for fittings. Integral moisture barrier. Provide pre-fabricated aluminum strapping and seals by same manufacturer, "Childers" or equal. Secure in place with factory supplied straps. Install all joints to prevent water entry. All joints shall be sealed with outdoor mastic. Benjamin Foster 65-07 or equal.

PART 3 EQUIPMENT

- A. Not Applicable

PART 4 INSTALLATION

- A. Equipment Connections

1. Water and drain connections shall be provided for each piece of equipment as required. Provide shut- off valve or fixture stop for each water supply to each piece of equipment whether or not equipment is furnished in this Specification Section.
2. Provide a backflow preventer at each connection to equipment as required by code whether or not equipment is provided in this specification section.
3. Provide a regulating valve at drinking fountain supplies. Valve, supply piping, and electrical connector shall be installed so as not to be visible.

- B. Piping

PLUMBING
SECTION 22 00 00

1. Constantly coordinate work with that of other trades so as to prevent any interference with this installation.
2. Piping shall be concealed in walls, above the ceilings, or below grade unless otherwise noted. Exposed piping shall run parallel to room surfaces; location to be approved by Engineer. No structural member shall be weakened by cutting, notching, boring or otherwise, unless specifically allowed by structural drawings and/or specifications. Where such cutting is required, reinforcement shall be provided as specified or detailed. All piping shall be installed in a manner to ensure unrestricted flow, eliminate air pockets, prevent any unusual noise, and permit complete drainage of the system. All piping shall be installed to permit expansion and contraction without strain on piping or equipment. Vertical lines shall be installed to allow for building settlement without damage to piping. Pipe sizes indicated on the drawings are nominal sizes unless otherwise noted.
3. Piping shall be run in alignment with building walls and all turns and bends shall be made with standard fittings. Springing or forcing piping into place will not be permitted. Hot and cold water piping shall be installed at 8" apart min., where possible.
4. Horizontal piping shall be supported at intervals with hangers as noted elsewhere in these Specifications. No piping shall be in contact with any part of the building structure, including sub-assemblies. Holes in structural elements to accommodate routing of vertical or horizontal piping shall provide a minimum of 3/16" clearance around piping surface. Piping secured directly to structure shall be provided with Semco "Trisolator".
5. Water piping shall be graded at 1/10" per foot and valved so as to provide for complete drainage of the systems. Branch water lines shall be taken off mains at top or at 45 degrees from vertical.
6. Install cleanouts at ends of sewer lines, at changes of direction greater than 45 degrees, and at not greater than 100 foot intervals. Locate interior cleanouts in accessible locations and bring flush to finished surface.
7. Vents shall terminate not less than 6" above the roof nor less than 12" from any vertical surface nor within 10' of any outside air intake. Install horizontal vent lines at 1/4" per foot pitch. Offset vents 2' minimum from gutters, parapets, ridges and roof flashing.
8. Gas Piping shall be pitched to drain to dirt legs at low points. No unions shall be installed except at connections to equipment. Provide shutoff and dirt leg

PLUMBING
SECTION 22 00 00

to each equipment connection. Only equipment mounted on vibration isolators shall be connected with flexible connectors. Under floor piping shall be sleeved and vented. Plastic pipe and fittings shall be joined in accordance with manufacturer's recommendations. Metal to plastic transition fittings shall be installed at all transitions. Install 14-gauge tracer wire alongside the pipe. Terminate tracer 6" above grade at both ends.

9. Condensate Drain Piping shall be installed with constant pitch of 1/8" per foot minimum. Provide tee with clean-out plug at all changes of direction. Provide a trap at each air handling unit to prevent air leakage. Connections to equipment mounted on vibration isolators shall be made with flexible connections.

10. Pipe Joints

- a) Pipe joints shall be smooth inside and cut pipe ends shall be thoroughly reamed to remove all burr.
- b) After general tests, any leaky connections shall be remade with new material. The use of thread cement or caulking to make joints tight is not permitted.
- c) All ends and openings in all pipe and fittings shall be taped or plugged immediately after installation to exclude dirt until fixtures are installed and/or until final connections are made.
- d) Electrical Equipment. Joints shall be avoided, where possible, over electrical equipment.

11. Unions

- a) A union shall be installed on the leaving side of each valve, at all sides of automatic valves, at equipment connections, and elsewhere as necessary for assembly or disassembly of piping.

12. Reducers

- a) Pipe size reduction shall be made with eccentric reducing fittings to eliminate air pockets. No bushings shall be used unless specifically noted. Close nipples shall not be used.

13. Rough-In

PLUMBING
SECTION 22 00 00

- a) Rough-in work shall proceed as rapidly as general construction will permit and shall be completed and tested before any lathing, plastering or any other finish work has started. Work shall be fitted to the available space and shall be accurately roughed-in.

14. Piping Expansion and Contraction

- a) Water pipe runs, except buried piping, shall be installed so that they may expand or contract freely without strain to the pipe or equipment. This may be accomplished through the use of swing joints, spring hangers, or expansion loops. Expansion loops shall be provided where required. Anchors shall be rigid and bolted to the structure and welded to the piping. Provide swing joints at point of connection to the equipment.

15. Grouting

- a) All pipes passing through the walls below grade shall be tightly packed with ionized grout, full thickness of intercepted wall. Grouting shall be between pipe exterior and sleeve.

16. Freeze Protection

- a) All piping two inch and smaller located outside building and above ground and where exposed to freezing conditions shall be neatly wrapped with refrigerant insulated tape for freeze protection.

17. Sterilization of Piping

- a) Disinfect all domestic hot and cold water piping systems in accordance with 2013 CPC 609.9, "Standard for Disinfecting Water Mains". Disinfecting process shall be performed by contractor and witnessed by a representative of the Engineer. During procedure signs shall be posted at each water outlet stating, "Chlorinating - Do not drink". After disinfecting, water samples shall be collected and sent to an independent lab for bacteriological analysis. Certificate of Bacteriological Purity shall be obtained from lab and delivered to the Owner through the Engineer.

C. Tests and Adjustments

1. General

- a) Unless otherwise directed, tests shall be witnessed by a representative of the Engineer. Work to be concealed shall not be enclosed until prescribed

PLUMBING
SECTION 22 00 00

tests are made. Should any work been closed before such tests, the Contractor shall, at his expense, uncover, test and repair all work to original conditions. Leak's and defects shown by tests shall be repaired and entire work retested. Tests may be made in section, however, all connections between sections previously tested and new section shall be included in the new test.

2. Gravity Systems

- a) Sanitary Sewer. All ends of the sanitary sewer system shall be capped and lines filled with water to the top of the highest vent, 10' above grade minimum. This test shall be made before any fixtures are installed. Test shall be maintained until all joints have been inspected, but no less than 2 hours. Grade tests will be allowed on "ring-tite" PVC pipe.
- b) Condensate Drain. Similar to Sanitary Sewer.
- c) Pressure Systems
 - 1) There shall be no drop in pressure during test except that due to ambient temperature changes. All components of system not rated for test pressure shall be isolated from system before test is made.
 - 2) Domestic Hot and Cold Water Piping: Maintain 100 psig water pressure for 4 hours.
 - 3) Gas Piping. Maintain 100 psig air pressure for 4 hours.

END OF SECTION

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

PART 1 – GENERAL

A. SCOPE.

1. Work Included. Provide all labor, materials and services necessary for complete, lawful and operating systems as shown or noted on the drawings or as specified here. The work includes, but is not necessarily limited to, the following:
 - a) Air distribution systems.
 - b) All equipment as shown or noted on the drawings or as specified.
 - c) System energy balance.
 - d) Demolition as indicated on drawings.
 - e) HVAC controls (see section 25 00 00).
 - f) Acceptance testing as required under California Building Energy Efficiency Standards, Title 24.
 - g) Coordination with acceptance testing technician (ATT) and / or commissioning agent. Acceptance testing and / or commissioning required where noted in construction documents or per code requirements.

B. CODES AND STANDARDS

1. All work and materials shall conform with current rules and regulations of applicable codes. Nothing in these Drawings or Specifications is to be construed to permit work not conforming to these codes. Should the Drawings or Specifications call for material or methods of construction of a higher quality or standard than required by these codes, the Drawings and Specifications shall govern.
2. Applicable codes and standards shall include but are not necessarily limited to:
 - a) California Code Of Regulations:
 - 1) Title 8, Industrial Relations
 - 2) Title 17, Public Health
 - 3) Title 19, Public Safety

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

- 4) Title 21, Public Works
- 5) Title 24, Energy Regulations
- b) California Building Code.
- c) California Mechanical Code
- d) California Plumbing Code
- e) Local Codes and Ordinances
- f) American Gas Association (AGA)
- g) Air Moving and Conditioning Association (AMCA)
- h) American National Standards Institute (ANSI)
- i) Air Conditioning and Refrigeration Institute (ARI)
- j) American Society of Heating, Refrigerating, and Air Conditioning Engineers
- k) American Society of Mechanical Engineers (ASME)
- l) American Society for Testing and Materials (ASTM)
- m) American Water Works Association (AWWA)
- n) Cast Iron Soil Pipe Institute (CISPI)
- o) National Electrical Code (NEC)
- p) National Electrical Manufacturers Association (NEMA)
- q) National Fire Protection Association (NFPA)
- r) National Sanitation Foundation (NSF)
- s) Occupational Safety and Health Act (OSHA)
- t) Plumbing and Drainage Institute (PDI)

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

- u) Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- v) Underwriters' Laboratory (UL)
- w) Requirements of local, state, and federal enforcing authorities codes and amendments to preceding codes shall be applicable to work performed under this specification.
- x) Americans with Disabilities Act. Accessibility Guidelines for Buildings and Facilities. (ADAAG).
- y) Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems as published by the sheet metal Industry fund of Los Angeles, California.

C. PERMITS AND FEES

1. The Contractor shall take out all permits and arrange for all tests in connection with such work as required. All charges are to be included in the work. All charges or fees for service connections, meters, etc., shall be included in the work.

D. COORDINATION OF WORK

1. Before starting any work, thoroughly examine all existing and newly completed underlying and adjoining work and conditions upon which the installation of this work is in any way dependent for the workmanship required by the Contract Documents. Report to the Architect and Engineer in writing any and all conditions which might adversely affect this work and limit ability to perform the required workmanship.
2. Layout of materials, equipment and systems is generally diagrammatic unless specifically dimensioned. The actual locations of all materials, piping, ductwork, fixtures, equipment, supports, etc., shall be carefully planned, prior to installation of any work, to avoid all interference's with each other, or with structural, electrical or architectural elements. Verify the proper voltage and phase of all equipment with the electrical plans. All conflicts shall be called to the attention of the Engineer prior to the installation of any work or the ordering of any equipment.
3. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate

HEATING, VENTILATING & AIR CONDITIONING

SECTION 23 00 00

the mechanical, electrical, structural, architectural drawings and field conditions that could affect the work to be performed and arrange such work accordingly. Provide the required piping and ductwork offsets, fittings, and accessories to meet such conditions.

4. Spaces provided in the design of the building shall be utilized and the work shall be kept within walls or furring lines established on the drawings. Any discrepancy between Architectural or Mechanical drawings with respect to wall or furring locations and dimensions shall be brought to the Architect's attention for resolution before proceeding with installation.
5. Any work which is done as an addition, expansion, or remodel of an existing system shall be compatible with that system.

E. MANUFACTURER'S RECOMMENDATIONS

1. All material, equipment, and devices, etc., shall be installed in a manner meeting approval of the manufacturer of the particular item. The Contractor shall make himself available of all installation manuals, brochures, and procedures that the manufacturer issues for the equipment and material. Contractor shall be held responsible for all installations contrary to the manufacturer's recommendations. Contractor shall make all necessary changes and revisions to achieve such compliance.

F. GUARANTEE

1. Guarantee shall be in accordance with the General Conditions. These Specifications may extend the period of the guarantee for certain items. Where such extensions are called for, or where items are normally provided with guarantee periods in excess of that called for in the General Conditions, the certificate of guarantee shall be furnished to the Owner.

G. QUIETNESS

1. Piping of all types, ductwork, and equipment shall be arranged and supported so that the vibration is at a minimum and is not transmitted to the building structure.

H. DAMAGES BY LEAKS

1. The Contractor shall be responsible for damages caused by leaks in the temporary or permanent piping or mechanical systems prior to completion of work and during the period of the guarantee.

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

I. SUBMITTALS

1. Shop Drawings. Within 30 days of contract award, the Contractor shall submit six copies of shop drawings for all materials, equipment, etc., proposed for use on this project. Material or equipment shall not be ordered or installed until written review is processed by the Engineer. Any item omitted from the submittal shall be provided as specified without substitution. All shop drawings must comply with the following:
 - a) Shop drawings are required for all material and equipment items and shall include manufacturer's name and catalog numbers, dimensions, capacities, performance curves, and all other characteristics and accessories as listed in the contract documents. Descriptive literature shall be current manufacturer's brochures and submittal sheets.
 - b) All shop drawings shall be submitted at one time in a three hole binder with title sheet including Project Title, Architect, Engineer, Contractor, table of contents, and indexed tabs dividing each group of materials or item of equipment. All items shall be identified by the specification paragraph number for which they are proposed. All equipment shall also be identified by the mark number as indicated on drawings. Submittals shall bear the stamp of certification by the Contractor as evidence that the Contract Documents (Specifications and Drawings) have been thoroughly checked.
 - c) All capacities, characteristics, and accessories called for in the specifications or on the drawings shall be high-lighted, circled or underlined on the shop drawings. Data must be complete enough to permit detailed comparison of every significant characteristic which is specified, scheduled or detailed.
1. Review. Submittals will be reviewed for general conformance with the design concept, but this review does not guarantee quantity shown, nor does it supersede the responsibility of the Contractor to provide all materials, equipment and installation in accordance with the drawings and specifications. The Contractor shall agree that shop drawing submittals processed by the Engineer are not Change Orders; that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

- a) If deviations, discrepancies or conflicts between shop drawings and design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Engineer, the design drawings and specifications shall control and shall be followed. Submittals for products and equipment offered as an alternate to that specified will require, if accepted by the Engineer, resubmission of the Title 24 Energy Compliance Calculations if the specified product or equipment was included within the scope of the approved calculations on file with the reviewing authority. The cost of preparing resubmission will be the responsibility of the Contractor.

J. OPENINGS, CUTTING AND PATCHING

1. The locations and dimensions for openings through walls, floors, ceilings, foundations, footings, etc. required to accomplish the work under this Specification Division shall be provided under this Division. Except as noted below, the actual openings and the required cutting and patching shall be provided by other Divisions. Coring through existing concrete or masonry walls, floors or asphaltic concrete required to accomplish the work under this Specification Division shall be provided under this Division. Restoration of all surfaces shall be provided by other Divisions. Cutting or coring shall not impair the strength of the structure. Any damage resulting from this work shall be repaired at the Contractor's expense to the satisfaction of the Architect and Engineer.

K. DEMOLITION

1. Existing equipment, ducts, piping, valves, fittings, devices, etc., requiring removal shall be removed and delivered to the Owner at a location on the job site to be determined by the Owner. Those items determined by the Owner to be of no value shall become the property of the Contractor and shall be removed from the job site by the Contractor at the Contractor's expense.
2. Existing piping, ducts, and services, etc., requiring capping or plugging shall be capped or plugged below floors, behind walls, above ceilings or above roof unless otherwise noted.

L. HANGERS AND SUPPORTS.

1. Provide all hangers and supports for the proper installation of equipment and materials under this Section of the Specification.
2. Any structural element required to properly hang or support piping, ducts, or equipment, etc., provided under this Specification Section and not shown on

HEATING, VENTILATING & AIR CONDITIONING

SECTION 23 00 00

the Architectural or Structural Drawings shall be provided under this Specification Section.

3. All [ducts] and [mechanical / plumbing piping] shall be supported and seismically braced in compliance with the Tolc / b-Line Restraint System, OSHPD OPM-0052-13 Copies of the above publication and details shall be provided by the Contractor and maintained at the project site until final acceptance.

M. CONTINUITY OF SERVICES

1. All existing services and systems shall be maintained except for short intervals when connections are to be made. The contractor shall be responsible for any interruptions of services and shall repair damage done to any existing service caused by the work.
2. If utilities not indicated on the drawings are uncovered during excavation, the Contractor shall notify the architect immediately for further instructions.

N. ELECTRICAL CONNECTIONS

1. Provide under Specification Division 15000 all required control conduit, wiring, controls and control panels as indicated on the drawings or as may be required for system operation.
2. No control device shall be mounted with rigid connections on vibration isolated mechanical equipment. No field furnished control device shall be mounted on any piece of equipment so that it interferes with physical access of air or water flow, or covers any portions of nameplates or access doors.
3. Electrical Coordination
 - a) Prior to commencing construction arrange a conference with the electrical and mechanical trades as well as equipment suppliers and verify types, sizes, locations, voltage requirements, controls and diagrams of all equipment furnished by them. In writing, inform the Architect that all phases of coordination of this equipment have been covered and if there are any unusual conditions or problems they shall be enumerated at this time.

O. FLASHING

- a) Whenever any part of the Mechanical System(s) must penetrate the roof or outside wall, the openings shall be flashed and counter-flashed

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

absolutely water tight with minimum 22 gauge galvanized sheet metal, prime coated. Flashing aprons shall extend not less than eight inches (8") from the duct, pipe, or supporting member in all directions unless detailed otherwise. All penetrations shall be flashed following the procedures of the National Roofing Contractor's Association.

P. PAINTING

- a) Paint all black iron supports, hangers, anchors, etc., and all uninsulated black iron pipe work installed in weather exposed locations with one coat of rust resisting primer.

Q. ACCESS DOORS AND PANELS

- a) Provide access doors as required where equipment, piping, valves, ductwork, etc. are not otherwise accessible. Access doors shall match the wall or ceiling finish and fire rating as indicated on the Architectural drawings or as required to match wall construction. 16-gauge steel frame and 14-gauge steel panel with paintable finish, except in ceramic tile, where panel shall be 16-gauge stainless steel with satin finish. Continuous hinge. Screwdriver latch. Deliver panels to the General Contractor for installation. Provide Zurn Z-1460-4 for square doors and Z-1460-5 for rectangular doors, Karp, or equivalent. Unless otherwise noted , the minimum sizes shall be as follows:

1 valve up to 1-1/2"	12"x12"
1 valve up to 3"	16"x16"
Fire damper, VAV box, coil	16"x16"

R. SYSTEM IDENTIFICATION

- a) Equipment. All equipment shall be identified with a plastic laminated engraved nameplate which bears the unit number marked as indicated on the drawings (e.g. AC-4, WH-1) Provide 1/2" high lettering - white on black background. Nameplates shall be permanently secured to the unit. Air conditioning equipment shall be identified as to area served.

S. CONCRETE ANCHORS

- a) Steel bolt with expansion anchor requiring a drilled hole - powder driven anchors are not acceptable. Minimum concrete embedment shall be 4½ diameters. Minimum spacing shall be 10 diameters center to center and 5 diameters center to edge of concrete. Maximum allowable stresses for tension and shear shall be 80% of the ICBO test report values. Hilti, Phillips. Wej-it.

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

T. DEFINITIONS

- a) Provide. The term "provide" as used in these specifications or on the Drawing shall mean furnish and install.
- b) Piping. The term "piping" as used in these Specifications or on the Drawings shall mean all pipe, fittings, nipples, valves, unions, hangers, and thermal insulation, etc., as may be required for a complete and functional system.
- c) Ductwork. The terms "duct" or "ductwork" as used in these Specifications or on the drawings shall mean all ducts, fittings, joints, dampers, hangers, and thermal insulation, etc., and other devices as may be required to make a complete and functional system.
- d) Wiring. The term "wiring" shall include the provision of all necessary products which are required for a complete installation and shall include products such as conduit, electrical boxes, connections, transformers, relays and switches.
- e) OSHPD. Office of Statewide Health Planning and Development.

U. PROJECT CLOSE-OUT

- a) Record Drawings
Provide in accordance with general conditions of the specifications.

- b) Operation and Maintenance Manual for Mechanical Systems

Provide three (3) copies of Operation and Maintenance Manuals to the Engineer for review and acceptance. Provide the Owner's designated representative with one copy of the approved O & M manual.

Bind Operation and Maintenance Manuals for each Mechanical System (Plumbing, Air Conditioning, etc.) in a hard-backed binder. Cover of each binder shall have the following lettering:

OPERATION
AND
MAINTENANCE
MANUAL
TAFT H.S GYM HVAC REMODEL

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

TAFT, CALIFORNIA

Provide a transmittal letter at the beginning of the manual on the Contractor's letterhead. Letter shall be signed by a contractor principal (Owner or Corporate Officer) and shall be countersigned by the Owner's designated representative and shall indicate the date when the mechanical systems were shown and explained in detail to the Owner's designated representative. (The Engineers office shall be notified 48 hours minimum prior to the owner-contractor meeting.)

Provide a master index at the beginning of Manual showing items included. Use plastic tab indexes for the sections of the Manual.

Section 1, General. Provide:

Name of Architect, Mechanical Engineer, Contractor and Mechanical Sub-Contractor.

A complete list of installed equipment with project mark number, indicating name of vendor, address and phone number.

A sub-section with manufacturer's descriptive literature for each item of installed equipment with model, capacities, and all other pertinent information highlighted.

Section 2, Operating instructions. Provide:

General description of each separate system and sub-system.

Step by step procedure to follow in putting each piece of mechanical equipment into operation. Start-up sheets must be signed by the owner of the installing contractor certifying that the start-up has been completed per manufacturer's written instruction.

Schematic as-built control diagrams for each separate system. Diagrams shall bear the date of the acceptance of the project. Include all temperature control panels and their respective functions.

Section 3, Maintenance Instructions. Provide:

Summary list of mechanical equipment used indicating name, model, serial number, and nameplate date of each item together with number and name associated with each system item.

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

Manufacturer's maintenance instructions for each piece of mechanical equipment installed in project. Instructions shall include name of vendor, installation instructions, parts numbers and lists, operation instructions of equipment and maintenance and lubrication instructions.

Section 4, Air Conditioning System Balance and Test Run Reports.
Provide:

One-half size reproduction of air conditioning plans annotated to match tabulated measurements.

Tabulated and summarized measurements.

Section 5, Warranties. Provide:

A copy of each manufacturer's warranty statement, completely filled out and indicating date forwarded to the respective manufacturer.

PART 2 - MATERIALS.

A. Ductwork.

2. General.

- h) Construct ductwork to meet all functional criteria defined in section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. This shall subsequently be referred to as the SMACNA manual.
- i) All interior ducts shall be constructed with G-60 or better galvanized steel (ASTM 527) LFQ, chem treat. Exterior ductwork or any duct exposed to high humidity conditions (i.e. dishwasher exhaust) shall be G-90 or better.
- j) Support, access doors not part of ducts, bar or angle reinforcing damper rods and items made of uncoated mild steel shall be painted with two coats of two coats primer or provide galvanized equivalent.

3. Rectangular Ducts.

- a) Construct ductwork and supports to meet all functional criteria defined in section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. Hanger spacing shall not exceed 8'.

4. Ells. Rectangular ells of ninety degrees shall be mitered and fitted with AERO/DYNE, "HEP" or equivalent, adjustable turning vane of airfoil contour design. Side rails shall be installed so that vane at heel of elbow shall fit

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

snugly without air passing on the back side. Spacing of vanes according to manufacturers recommendations.

5. Round Ducts.

a) Galvanized.

- I. United McGill "Uni-Rib" spiral lockseam with standing rib duct. For round ducts, 8" diameter or less, provide Noll or Young and company snap-lock galvanized steel.
- II. Round elbows shall be United McGill pleated or welded gore for use with "Uni-Seal" or "Uni-Rib" ducts (5 piece ells) Non-welded gore elbows for use with snap lock ducts shall be taped at gore intersections.

6. Duct Joints.

- a) Rectangular. All ducts shall utilize "Ductmate 25/35" factory fabricated duct joint connectors with #440 gasket tape. Flanged interior gaskets shall be Ductmate #440 or Butyl Rubber Gasket which meets Mil-C 18969B, Type II Class B, and TTS-S-001657 must also pass UL-723. The material must not contain any vehicle that will support fungal or bacterial growth. Formed on flanges shall not be accepted for any duct exceeding 42" in width or any duct subjected to greater than 2" W.G..
- b) Round. All round ducts shall utilize male-female slip joints with minimum three (3) sheet metal screws. 0-20" ducts shall utilize sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3" wide duct tape. 21" – 72" ducts, use 3-piece, gasketed, flanged joints consisting of two internal flanges (with integral mastic sealant), and one external closure band. Ductmate Spiralmate or equal.

7. Taping.

- a) Interior to Building - Hardcast fiber tape and liquid adhesive. DT-5300 or DT-540 tape. FTA-20 adhesive. Ductmate PROseal.
- b) Exterior to Building - For joints exposed to weather, sealant shall be G.E. silicone. For joints not exposed to weather, sealant shall be Eco-Duct Seal 44-60, or United Sheet Metal.
- c) Exposed Ducts. All joints shall use Hardcast Galva-Grip or equivalent. Joint shall be finished clean from outward appearance.

8. Flexible Insulated Ducts.

- a) Shall be J.P. Lamborn Company Type AMF-07 or Thermoflex M-KE acoustical low pressure duct. Duct shall be listed and labeled UL-181 Air

HEATING, VENTILATING & AIR CONDITIONING

SECTION 23 00 00

Duct; meet NFPA-HUD minimum standards and comply with UMC 6. Duct factory R-value 4.2 minimum. In un-conditioned spaces, R-8 minimum.

- b) Hangers shall consist of minimum 3" wide 28 gauge galvanized steel and shall be spaced a maximum of 36" on center. Flexible duct shall be installed in compliance with the manufacturer's latest installation instructions. No kinks or sharp bends allowed. Turning radius shall be a minimum of 1.5 times diameter of duct. A copy of which shall be at the site during and after installation. Provide a minimum of at least one hanger per duct section.
- c) Connections to round ducts or collars shall be made with galvanized or stainless steel worm clamps or "Panduit" adjustable clamps listed by UL-181.
- d) Unless indicated otherwise on the drawings, flexible duct shall be limited to the final 5 foot portion of the duct system connecting to the supply diffuser or return grille. Flex duct shall be limited to factory cut pieces with factory applied end connections.

B. Fire Dampers.

- 1. Fire damper assembly shall bear the U.L. 555 Label and the California State Fire Marshall listing number. Provide duct access door to fire damper as required by job conditions in compliance with Title 24, California Mechanical Code. Fire dampers shall be installed in all rated walls and ceilings penetrated by ducts, grilles and diffusers. Fire damper shall have rating equivalent to construction. Dampers shall be installed in strict compliance with manufacturer's installation instructions.

C. Fire/Smoke Dampers.

- 1. Damper Assembly shall bear the U.L. 555S Label and State Fire Marshall listing number. Provide access door to smoke damper as required by job conditions in compliance with Title 24, California Mechanical Code. Means of disconnect shall be provided between detector and damper(s), where detector is included as factory mounted and wired. Dampers shall meet most current standard for UL testing. UL555 and UL555S. Dampers shall be suitable for a dynamic system. See details on plans for leakage and velocity requirements. If not listed on plans, provide leakage class I and velocity level at 3,000 FPM.

D. Volume Dampers.

- 1. Branch Duct Volume Damper - Volume control damper (VCD) in square or rectangular ducts shall be as follows: Opposed blade, 6" maximum blade width, 16- gauge blade, 48" maximum length, nylon or oil impregnated bronze bearings, 1/2" diameter pin shaft, 16-gauge channel frame, actuating rod out of air stream. VCD in round duct shall be as follows: Damper blade full height of branch and 1" less than branch width. All branch dampers shall have regulator

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

with spring loaded shaft nut and serrated self-locking die cast core. Ventlok 640. Provide remote ceiling operator with chrome plated or painted cover where shown on drawings or where damper control is otherwise inaccessible.

E. Back-draft Dampers.

1. Unless otherwise noted on drawings: .025 aluminum counter-balanced blades with felt strip on mating edges, and machined brass mounted in six gauge steel channel frame, Pacific Model PRO 1100AI or equal. Normally closed back-draft dampers are required at all roof exhaust fans and all outside air intakes.

F. Filters.

1. Pre-Filters.

- a) Minimum of MERV 13 filter, consisting of a nominal 2" thick, pleated type, panel filter, CSFM listed. Initial resistance at 500 feet per minute face velocity shall not exceed 0.30" w.g. Provide one complete change of all filters after air balance is completed and prior to final acceptance.

G. Duct Fire Caulking.

1. All ductwork passing through rated assemblies that do not have a fire or fire/smoke damper shall be installed with a U.L. listed fire caulking assembly. Exact details of U.L. listed assembly shall be followed. Provide inspector of record and project engineer submittal showing U.L. listed fire caulking detail that the contractor intends to use for each condition. In lieu of fire caulking, at contractors option, provide fire damper installed in accordance with U.L. listing.

H. INSULATION.

1. General.

- a) Insulation shall be provided in accordance with the "National Insulation Contractors Association" manuals. Insulation, except for interior duct liner, shall be applied by a Contractor holding a valid California C-2 License.
- b) All insulation shall be in strict compliance with California Building Energy Efficiency Standards, 2019 Edition, Title 24.
- c) Refer to table 120.3-A for pipe insulation thickness required. This shall be a minimum. If construction documents call for a higher rating, the higher rating shall apply.
- d) Insulation shall have a flame spread of not more than 25 and a smoke developed rating of not more than 50.

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

2. Ducts.

- a) General. All supply, return, exhaust ducts and plenums shall be insulated externally and/or lined internally as specified herein or as indicated on the drawings. Ducts in directly or indirectly conditioned spaces shall be insulated to a minimum level of R4.2. Ductwork in unconditioned spaces such as an attic where the roof insulation is at the ceiling level or where located outdoors shall have an insulation level of R8 minimum.
- b) Ducts in Attics. All supply and return ducts shall be insulated externally with 2" thick fiberglass 3/4# density. Where rectangular ducts are lined internally, they shall be wrapped on the exterior with 1" thick fiberglass, 3/4# minimum density.
- c) Exposed Ducts Within Conditioned Spaces. Shall not require external insulation unless noted on the drawings.
- d) Ducts Exposed to Weather. All supply and return ducts shall be lined internally with 2" thick Manville "Permacote Linacoustic" glass fiber and thermosetting resin duct liner, R-8. Provide with antimicrobial edge coating, Johns Manville Superseal Edge Treatment or Superseal HV. Coating edges with adhesive is not acceptable. All field cut edges must be coated prior to delivering duct to job site. Any lined duct left untreated that has been subjected to dirt and / or dust will be rejected, and will not be accepted for installation. Edges must be treated so that complete coverage is obtained, with no raw edges. Apply as directed by manufacturer's literature.
- e) Interior Duct Surfaces. All supply, return, or exhaust duct connections to air conditioning units or fans shall be internally lined for a minimum distance of ten lineal feet upstream and downstream of fan unless otherwise indicated on the drawings. Interior duct liner where applied for attenuation purposes only shall be 1" thick Manville "Permacote Linacoustic" glass fiber and thermosetting resin duct liner, R-4.2. Provide with antimicrobial edge coating. See paragraph above.

3. Application.

- a) Duct Wrap. Shall be tightly wrapped around ducts to prevent sagging with longitudinal and transverse lap of at least 6". Laps shall be wired or stapled to eliminate gaps. Insulation shall be secured by wrapping with 18 gauge galvanized wire 12 o.c. adhesive. Insulation shall be applied with density identification exposed.
- b) Duct Liner Shall be adhered to clean metal with minimum 100% coverage of adhesive such as 3M Adhesive #38, additionally secured with approved mechanical clips or welded pins per SMACNA standards. Provide with antimicrobial edge coating. Apply per paragraph 2 d) above. Coating edges with adhesive is not acceptable.

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

4. Refrigerant. Cover piping with foamed plastic insulation. Longitudinal and end seams shall be thoroughly cemented with adhesive in accordance with manufacturer's recommendations. Cover all fittings, unions, valves and connections. Piping exposed to weather shall be covered with at least two coats of protective finish. Piping exposed to weather shall be Aluma-Clad.

PART 3- EQUIPMENT.

A. General Requirements

1. Start-up. All equipment shall be started and tested in strict accordance with the manufacturer's written instructions. Provide the inspector of record factory start-up literature for each mechanical item. Demonstrate to inspector that strict compliance to the start-up procedure has been completed for each item. Start-up sheets must be completed and turned in with the O&M manuals. Start-up sheets must be signed by the owner of the installing contractor certifying that the start-up has been completed per manufacturer's written instruction.
2. Acceptance Testing. Complete acceptance testing of all systems and equipment as required under the Building Energy Efficiency Standards, 2013 Edition, Title 24. Submit all completed and signed forms to the building department or the Division of the State Architect, where applicable.
3. Capacity. Capacities shall be in accordance with schedules shown on drawings. Capacities are to be considered minimum.
4. Dimensions. Equipment must conform to space requirements and limitations as indicated on drawings and as required for operation and maintenance. Where architectural screening is indicated, equipment shall not extend above or beyond screening. Equipment is not acceptable that does not readily conform with the space conditions. Prepare and submit layout drawings for all proposed equipment (different than scheduled units) showing actual job conditions, required clearances for proper operation, maintenance, etc.
5. Ratings.
 - a) Gas. Natural gas burning equipment shall be furnished with 100% safety gas shut-off, intermittent pilot ignition, and be approved by AGA.
 - b) Electrical. Electrical equipment shall be in accordance with NEMA Standards and UL listed where applicable standards have been established.
6. Piping. Each item or assembly of items shall be furnished completely piped for connection to services. control valves and devices shall be provided. Equipment requiring domestic water for none-potable use shall be provided with backflow preventer acceptable for intended use by local governing authorities.

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

7. Electrical.

- a) General. Each item or assembly of items shall be furnished completely wired to individual terminal blocks for connection to single branch electrical circuit. All electrical accessories and controls required by equipment shall be provided. Provide terminal blocks for controls and interlocks not included in equipment package.
- b) Wiring. Conductors, conduit, and wiring shall be in accordance with Electrical Specifications. Individual items within assembly shall be separately protected with dead front, fused disconnect, fuse block, or circuit breaker for each underground conductor. Switches, contacts and other devices shall be in undergrounded conductors.
- c) Motors. Shall be rated, constructed and applied in accordance with NEMA and ANSI Standards without using service factor. Single-phase motor shall be of type to suit application. Three- phase motors shall be of type to suit application. Three-phase motors shall be open drip proof, NEMA B design on pumps and fans, NEMA C on reciprocating equipment, sealed ball bearing, three-phase indication. Insulation shall be double dip and bake with Class F thermal polyester non-hygroscopic epoxy base insulating materials. Design shall limit starting inrush current and running current to values shown on drawings. Motors exposed to weather shall be open drip-proof approved by manufacturer for this type of service. All motors 1 horsepower and larger shall be the high efficiency type with efficiency and power factor equal or exceeding Century E-Plus.

8. Fan Selection.

- a) Fan Curves. Performance curves shall be submitted for all units of 3000 CFM or greater. Operating point for forward curved fans shall be from point of maximum efficiency toward increased CFM limited by horsepower scheduled. Operating point for backward inclined fans shall be selected near point of maximum efficiency. Curves shall plot CFM verses static pressure with constant brake horsepower, RPM and efficiency lines.
- b) Static Pressure. Unless otherwise noted, pressure scheduled as external static pressure (ESP) includes all ductwork and accessory losses external to the unit housing. Unless otherwise noted, pressure scheduled as total static pressure includes all ductwork, filter, coil, cabinet, damper and other accessory losses. Unless otherwise noted, pressure scheduled as duct static pressure includes all supply and return ductwork and accessory losses external to the unit housing and plenum (as applicable). The allowance for filter losses is 0.3" WC, unless otherwise noted. Submit itemized static pressure losses for all components.

9. Screens. All duct or louver openings to the outside shall be covered with 1/4" galvanized screen.

HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00

10. Mixing Dampers. Opposed blade, 16-gauge. Six-inch maximum blade width, 48" maximum length. Nylon or oil impregnated bronze bearings. One-half inch diameter pin shaft. 16-gauge channel frame. One percent maximum leakage at 4" WC in accordance with AMCA 500 for outside air dampers. Actuating rod out of air stream.

PART 4 - INSTALLATION

A. Ductwork.

1. General.

- a) Installation shall conform with NFPA 90A and SMACNA Low Pressure Duct Construction Standards 2005 Edition. Provide mounting and supporting of Ductwork and accessories including, but not limited to, structural supports, hangers, vibration isolators, stands, clamps and brackets, access doors, and dampers. Install ductwork accessories as indicated in accordance with the manufacturer's printed instruction. Allow clearance for inspection, repair, replacement, and service. Ductwork and accessories shall be installed in a manner to prevent vibration and rattling.

2. Deflectors.

- a) Provide in rectangular elbows, duct mounted supply outlets, take-off or extension collars to supply outlets, and tap-in branch take-off connections. 45 degree take-off is an acceptable alternative for low velocity systems (below 1,500 FPM).

3. Support.

- a) All [ducts] and [mechanical piping] shall be supported and seismically braced in compliance with the Tolc / B-line Restraint system, OSHPD OPM 0052-13. Copies of the above publication and details shall be provided by the Contractor and maintained at the project site until final acceptance.

4. Grilles.

- b) Each air inlet and outlet shall be flush with finished surface of wall or ceiling and shall be securely attached thereto. Provide plaster grounds at locations of all wall and hard surfaced ceiling grilles.

5. Branch Take-Offs.

- a) All branch ducts from main supply air and to return air trunk duct shall be provided with splitter blade full height of branch take-off and 1" less than branch width. Regulators to be Young or equal. Dampers located in inaccessible areas shall have extended shafts with concealed regulator in adjacent ceiling or wall.

**HEATING, VENTILATING & AIR CONDITIONING
SECTION 23 00 00**

6. Access.

- a) Provide duct access doors as required to adjust equipment and dampers. Provide wall or ceiling access panels, or remote actuators as required where equipment and dampers are not otherwise accessible.

7. Dampers.

- a) Install volume control damper and damper regulator on all branch ducts.

8. Flexible Glass Fiber Duct.

- a) The use of flexible duct is limited to the last 5 feet of each branch duct (i.e. one 5 foot section of flexible duct may be used to connect the grille to the sheet metal branch duct). No joints permitted in 7' length. Joints shall be installed with metal bands and fiber tape and adhesive. Minimum turn radius shall be in accordance with SMACNA Standards (turn radius of duct centerline not less than 1.5 times the duct diameter).

B. Piping.

1. General.

- a) Piping Layout: Piping shall be concealed in walls, above the ceilings, or below grade unless otherwise noted. Exposed piping shall run parallel to room surfaces; location to be approved by Engineer. (No structural member shall be weakened by cutting, notching, boring or otherwise, unless specifically allowed by structural drawings and/or specifications. Where such cutting is required, reinforcement shall be provided as specified or detailed.) All piping shall be installed in a manner to ensure unrestricted flow, eliminate air pockets, prevent any unusual noise, and permit complete drainage of the system. All piping shall be installed to permit expansion and contraction without strain on piping or equipment. Vertical lines shall be installed to allow for building settlement without damage to piping. Pipe sizes indicated on the drawings are nominal sizes unless otherwise noted.

2. Refrigerant Piping.

- a) Pipe shall be cut square. Joint surfaces shall be thoroughly cleaned, fitted and erected before brazing. After installation, evacuate to 29 inches of mercury, ambient temperature during evacuation, fill with dry nitrogen to 250 psi and maintain for two-hour period without additional charge. After nitrogen test, purge with refrigerant charged through dryer and maintain holding charge in system and equipment.

C. Temperature Controls (see section 25 00 00):

END OF SECTION

EMCS: Start-up, Verification and Commissioning
SECTION 25 01 11

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .10 SECTION 25 35 19, EMCS: Control Valves
- .11 SECTION 25 35 23, EMCS: Control Dampers
- .12 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .13 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.
 - .1 CDL - Control Description Logic.
- .2 AEL: ratio between the total test period less any system downtime accumulated within that period and test period.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
 - .1 Outage of main power supply in excess of back-up power sources, provided that:
 - .1 Automatic initiation of back-up was accomplished.
 - .2 Automatic shut-down and re-start of components was as specified.
 - .2 Failure of communications link, provided that:
 - .1 Controller automatically and correctly operated in stand-alone mode.
 - .2 Failure was not due to failure of any specified EMCS equipment.
 - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
 - .1 System recorded said fault.
 - .2 Equipment defaulted to fail-safe mode.
 - .3 AEL of total of all input sensors and output devices is at least [99] % during test period.

1.3 DESIGN REQUIREMENTS

- .1 Confirm with Taft Union High School District, Factory Authorized DDC Contractor that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section [25 05 01 EMCS General Requirements].
- .2 Final Report: submit report to Taft Union High School District, Factory Authorized DDC Contractor .
 - .1 Include measurements, final settings and certified test results.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .2 Bear signature of commissioning technician and supervisor
- .3 Report format to be approved by Taft Union High School District, Factory Authorized DDC Contractor before commissioning is started.
- .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Taft Union High School District, Factory Authorized DDC Contractor in accordance with Section [25 05 01 EMCS General Requirements].
- .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Taft Union High School District, Factory Authorized DDC Contractor before interim acceptance in accordance with Section [25 05 01 EMCS General Requirements].

1.6 COMMISSIONING

- .1 Do commissioning in accordance with Section [25 05 01 EMCS General Requirements].
- .2 In addition to Division 25 commissioning, the EMCS contractor is to perform commissioning for lighting as described in Division 25 and the referenced section(s) of Division 26 by Division 25.
- .3 Carry out commissioning under direction of Taft Union High School District, Factory Authorized DDC Contractor and in presence of Taft Union High School District, Factory Authorized DDC Contractor .
- .4 Inform, and obtain approval from, Taft Union High School District, Factory Authorized DDC Contractor in writing at least [14] days prior to commissioning or each test. Indicate:
 - .1 Location and part of system to be tested or commissioned.
 - .2 Testing/commissioning procedures, anticipated results.
 - .3 Names of testing/commissioning personnel.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .5 Correct deficiencies; re-test in presence of Taft Union High School District, Factory Authorized DDC Contractor until satisfactory performance is obtained.
- .6 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .7 Load system with project software.
- .8 Perform tests as required.

1.7 COMPLETION OF COMMISSIONING

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Taft Union High School District, Factory Authorized DDC Contractor .

1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than [2] months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

PART 3 - EXECUTION

3.1 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .2 Commission each system using procedures prescribed by the Taft Union High School District, Factory Authorized DDC Contractor .
- .3 Commission integrated systems using procedures prescribed by Taft Union High School District, Factory Authorized DDC Contractor .
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

- .1 Pre-installation Testing
 - .1 General: consists of field tests of equipment just prior to installation.
 - .2 Testing may be on site or at Contractor's premises as approved by Taft Union High School District, Factory Authorized DDC Contractor .
 - .3 Configure major components to be tested in same architecture as designed system. Include 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
 - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
 - .5 Additional instruments to include:
 - .6 DP transmitters.
 - .7 VAV supply duct SP transmitters.
 - .8 DP switches used for dirty filter indication and fan status.
 - .9 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of adequate air pressure to operate any pneumatic device used, to hold steady at any setting and with direct output to milli-amp meter at source.
 - .10 After setting, test zero and span in [10] % increments through entire range while both increasing and decreasing pressure.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .11 Taft Union High School District, Factory Authorized DDC Contractor to mark instruments tracking within [0.5]% in both directions as "approved for installation".
- .12 Transmitters above [0.5]% error will be rejected.
- .13 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing
 - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
 - .2 Include following activities:
 - .1 Test and calibrate field hardware including stand-alone capability of each controller.
 - .2 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.
 - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
 - .7 Test operating software.
 - .8 Test application software and provide samples of logs and commands.
 - .9 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Blow out flow measuring and static pressure stations with high pressure air.
 - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Taft Union High School District, Factory Authorized DDC Contractor . This document will be used in final startup testing.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .3 Final Start up Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Taft Union High School District, Factory Authorized DDC Contractor and provide:
 - .1 [2] Technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Commissioning to commence during final start-up testing.
 - .4 O&M personnel to assist in commissioning procedures as part of training.
 - .5 Commissioning to be supervised by qualified supervisory personnel and Taft Union High School District, Factory Authorized DDC Contractor .
 - .6 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .7 Operate systems as long as necessary to commission entire project.
 - .8 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
 - .1 Prior to beginning of [30] day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
 - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
 - .2 Test to last at least [30] consecutive 24 hour days.
 - .3 Tests to include:
 - .1 Demonstration of correct operation of monitored and controlled points.
 - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

SECTION 25 01 11
EMCS: Start-up, Verification and Commissioning

- .4 System will be accepted when:
 - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
 - .2 Requirements of Contract have been met.
- .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
- .6 Correct defects when they occur and before resuming tests.
- .5 Taft Union High School District, Factory Authorized DDC Contractor to verify reported results.

3.3 ADJUSTING

- .1 Final adjusting: upon completion of commissioning as reviewed by Taft Union High School District, Factory Authorized DDC Contractor, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

- .1 Demonstrate to Taft Union High School District, Factory Authorized DDC Contractor operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section [01 79 00 - Demonstration and Training].

END OF SECTION

**EMCS: TRAINING
SECTION 25 01 12**

PART 1 - GENERAL

- .1 SECTION 25 01 11, EMCS: Start-up, Verification and Commissioning
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .10 SECTION 25 35 19, EMCS: Control Valves
- .11 SECTION 25 35 23, EMCS: Control Dampers
- .12 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .13 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section [01 33 00 - Submittal Procedures], supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Taft Union High School District, Factory Authorized DDC Contractor [30 days] prior to the anticipated commencement date of training.
 - .1 List name of trainer, and type of visual and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within [one week] after completion of [Phase 1] [Phase 2] training program that training has been satisfactorily completed.

**EMCS: TRAINING
SECTION 25 01 12**

1.3 QUALITY ASSURANCE

- .1 Provide [bilingual] competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Taft Union High School District, Factory Authorized DDC Contractor reserves right to approve instructors.

1.4 INSTRUCTIONS

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific and relevant to the EMCS system described herein.

1.5 TIME FOR TRAINING

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.6 TRAINING MATERIALS

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.
 - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.7 TRAINING PROGRAM

- .1 To be in 2 phases over [6] month period.
- .2 Phase 1: [2] day program to begin before 30 day test period at time mutually agreeable to Contractor, Taft Union High School District, Factory Authorized DDC Contractor .
 - .1 Train O&M personnel in functional operations and procedures to be employed for system operation.
 - .2 Supplement with on-the-job training during 30 day test period.
 - .1 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

EMCS: TRAINING

SECTION 25 01 12

- .2 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: [5] day program to begin [8] weeks after acceptance for operators, equipment maintenance personnel and programmers.
 - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
 - .2 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
 - .3 Equipment maintenance training: provide personnel with [2] days training within [5] day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
 - .4 Programmers: provide personnel with [2] days training within [5] day period in following subjects in approximate percentages of total course shown:
 - .1 Software and architecture: [10]%
 - .2 Application programs: [15]%
 - .3 Controller programming: [50]%
 - .4 Trouble shooting and debugging: [10]%
 - .5 Colour graphic generation: [15]%

1.8 ADDITIONAL TRAINING

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.9 MONITORING OF TRAINING

- .1 Taft Union High School District, Factory Authorized DDC Contractor to monitor training program and may modify schedule and content.

END OF SECTION

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

PART 1 - GENERAL

1.1 Related Sections

- .1 SECTION 25 01 11, EMCS: Start-up, Verification and Commissioning
- .2 SECTION 25 01 12, EMCS: Training
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .10 SECTION 25 35 19, EMCS: Control Valves
- .11 SECTION 25 35 23, EMCS: Control Dampers
- .12 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .13 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 SCOPE OF WORK

- .1 This project requires the installation of a new Integrated Automation System constructed using BACnet Field Level Devices. The IAS shall utilize single or multiple Network Control Units (NCUs) based on point counts and available resources utilizing a web interface to all controlled devices.
- .2 The Contractor will be required to perform the following:
 - .1 Furnish and install a new Integrated System with BACnet fully programmable and application specific DDC controllers for the equipment identified in the IAS drawings including:
 - .1 Central Plant
 - .2 Lighting

**EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01**

- .3 Irrigation Water
 - .4 Sensors
 - .5 Electric sub-meters
 - .6 List additional equipment to be controlled and/or monitored.
 - .7 Integration of (identify other systems to be integrated)
 - .8 Integrate the intelligent advanced meter data.
 - .9 Integration of new BACnet DDC controllers with Network Controller(s).
-
- .3 Contractor to confirm actual location and capacity of Network Controllers.
 - .4 Provide Graphical User Interface Development for all of the devices identified above and illustrated within the IAS drawings.
 - .5 Graphical User Interface development must match existing graphics, tool sets and features.
 - .6 Refer to Section 25 15 00.
 - .7 Furnish and install all items listed below in Section 1.3 GENERAL IAS INSTALLATION SCOPE OF W.
 - .8 It is the contractor's responsibility to review all of the design documents and specifications and report any discrepancies to the owner.

1.3 GENERAL IAS INSTALLATION SCOPE OF WORK

- .1 Contractor shall or install a new IAS by furnishing and installing system to provide an open protocol, enterprise based, direct digital control, Integrated Automation System.
- .2 The new IAS components shall utilize network controllers, BACnet protocol, BTL certified devices, enterprise connectivity, electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified.
- .3 The IAS will consist of monitoring and control of systems identified within the IAS drawings, which include integration of HVAC, power monitoring, lighting control and other systems as outlined.
- .4 The installation of Network Controllers and DDC control system devices for the HVAC equipment as illustrated on the IAS drawings and detailed in these specifications.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .5 This includes all hardware, electrical installation, configuration, programming and commissioning coordination for the DDC system.
- .6 Contractor shall implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.
- .7 The Owner shall be the named license holder of all software associated with any and all incremental work on the project.
- .8 Provide an Integrated System supplied by a company regularly engaged in the manufacturing and distribution of building automation systems. The IAS Manufacturer shall meet the following qualifications as a minimum:
 - .1 The manufacturer of the hardware and software components must be primarily engaged in the manufacture of building integration automation systems as specified herein, and must have been so for a minimum of three (3) years.
 - .2 The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International.
 - .3 At least 75% of the manufacturer's product line shall be produced under their own direction, including R&D and assembly. Rebranding of another manufacture product shall not qualify.
- .9 The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
- .10 The Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project.
 - .1 This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices.
 - .2 Any and all required IDs and passwords for access to any component or software program shall be provided to the Owner.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .11 Intelligent Equipment Integration. Network installation, software integration, network communication, and equipment configuration for all equipment types specified to be "Intelligent" shall be provided with a factory installed or equipment manufacturer provided communication card.
- .12 Refer to IAS drawings and coordinate with Mechanical and Electrical contractors to verify the correct communication options have been supplied.
- .13 Coordination with other trades to ensure that all equipment to be integrated is ordered with the proper communication cards and/or equipment required for proper integration.
- .14 Installation of the new Facility Local Area Network (FAC LAN) as specified on the Drawings and in these specifications to add new controllers to the IAS infrastructure.
- .15 All hardware installed for the project shall be constructed in a modular fashion to permit the next generation and support components to be installed in replace of or in parallel with existing components.
- .16 Where the project is an expansion of an existing system the Software utilized for the project shall be downward compatible with earlier releases, whenever possible.
- .17 System Integrator shall be responsible to upgrade hardware purchased due to the introduction of software upgrades prior to system acceptance which supersede or replace the version used for IAS Local Area Network operations or other functions specified herein.
- .18 Provision of all documentation called out in these specifications including, but not limited to, submittals, O&M manuals, commissioning submittals, CAD based as-built documentation, and training manuals.
- .19 Provide both hard copies and electronic files on electronic media.
- .20 Training of facility personnel, and or maintenance contractor, on the operation and maintenance of the system as called out in these specifications.
- .21 Hardware, Software and Labor as detailed and described on the IAS drawings and the Division 25 specifications.
- .22 Coordination and assistance provided to the owners representative for system commissioning.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .1 This includes providing staff to operate and manipulate the system as required by the commissioning authority in addition to providing the requested documentation as defined in the commissioning specification.
- .2 Provide 16 hours of assistance to the commissioning authority as required.
- .23 The repair of all finished surfaces effected as a result of IAS related installation work. This includes but is not limited to carpet, drywall, paint ceiling tiles, furniture, and the like.
- .24 DDC Controller programming and commissioning.
 - .1 System point to point check out, verification and documentation.
- .25 Graphical User Interface Development.
 - .1 The Contractor shall develop the graphics, tools, features, and network integration required and as defined in section 25 15 00.
- .26 The low voltage and communication raceway systems, wiring and terminations.
- .27 All requirements, products, and labor as identified in the Division 25 specifications and IAS Drawings.

1.4 CODES

- .1 Comply with all current codes, ordinances, regulations, and the City of Taft.
- .2 In all cases of conflict between the work of this Division and the City of Taft Building Code or omission of items required for code compliance, these details shall be brought to the attention of the Owner at the time of bid proposal submission.
- .3 It is the Contractor's responsibility to identify any items of conflict or omission.
- .4 These items shall be resolved prior to bid submission and included in the bid proposal price.
- .5 The IAS work, materials, and equipment shall comply with the latest rules and regulations of applicable local, state, and federal codes and ordinances.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .6 Where codes are listed herein, the applicable portions of the latest editions apply.
- .7 Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
- .8 Should any change in Drawings or Specifications be required to comply with regulations, the Contractor shall notify the Owner prior to execution of the work and wait for direction from the Owner.

1.5 REFERENCE STANDARDS

- .1 The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- .2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- .3 All materials, installation and workmanship whose compliance with organizational standards/codes/specifications is regulated by an organization using its own listing or label as proof of compliance, furnish listing or label as required to ensure material complies with applicable referenced standard or specification.
- .4 All materials, installation and workmanship whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.6 COORDINATION OF WORK WITH EXISTING CONDITIONS

- .1 Examine and compare the Integrated Automation System (IAS) Specifications and Drawings with the Specifications and Drawings of the other trades and report any discrepancies between them to the Owner.
- .2 Obtain the Owner's written instructions for changes necessary in the IAS work. Install and coordinate the IAS work in cooperation with the Commissioning Authority and the other trades installing interrelated work.
- .3 Before installation, make proper provisions to avoid interferences in a manner approved by the Owner.
- .4 All changes required in the work of the Contractor, caused by noncompliance with the specifications, shall be made at the Contractor's expense.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .5 Certain products, systems and interface devices may be provided by other trades.
- .6 Examine the Contract Documents to ascertain the requirements to install, wire, program, commission, and/or interface to these systems.
- .7 Particular attention must be paid towards the interface boards submitted by the various equipment providers.
- .8 It is the Contractor's responsibility to verify the submitted interfaces will integrate properly into the IAS. Report any discrepancies to the Owner.
- .9 Carefully check space requirements with other trades to insure that all material can be installed in the allotted spaces, including above finished suspended ceilings and under floors.
- .10 Transmit to other trades information required for work to be provided under their respective sections in ample time for installation.
- .11 Wherever work interconnects with work of other trades, coordinate with other trades and with the Owner's representative to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment.
- .12 Identify all work items (valves, dampers, coils, etc.) in an accepted manner and notify the responsible trade to install access doors and panels at these locations.
- .13 Provide notification in writing to both the contractor and the Owner of these locations.
- .14 Provide sleeves and conduit for passage of pipes, and wiring through structural masonry, concrete walls and floors, and elsewhere for the proper protection of the IAS work.
- .15 Coordinate, project and schedule work with other trades and with the Commissioning Authority in accordance with the construction sequence.
- .16 Adjust locations of panels, equipment, devices, and the like, to accommodate work and prevent interferences. Determine the exact route and location of each pipe, conduit or tubing prior to fabrication and installation.

1.7 PARTS LIST

- .1 As part of the submittal, provide an accurate parts list including manufacturer, model number and quantity.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

1.8 DEFINITIONS

- .1 Adjustable (Adj): A characteristic of a control logic parameter such that it can be varied by the operator without downloading the program.
- .2 Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.
- .3 Algorithm: A logical procedure for solving a recurring problem.
- .4 Analog: A continuously varying signal value (temperature, current, velocity, etc.).
- .5 Application Programming Tool: A vendor unique software tool used to create applications for programmable controllers. This software tool may also be used for system programming, controller commissioning, network management.
- .6 Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).
- .7 Application Specific Controller (ASC): Control product that incorporates solid-state components based upon a microprocessor to perform multiple control loops or functions as part of a specific application.
 - .1 ASC shall conform to the BACnet/BTL certification and integration standards
- .8 BACnet or BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes.
- .9 BACnet Interoperability Building Blocks (BIBB): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task.
 - .1 BIBBS are combined to build the BACnet functional requirements for a device in a Specification.
- .10 BACnet over Internet Protocol (BACnet/IP): BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes utilizing Internet Protocol addressing as described in IETF publication RFC 791.

EMCS: GENERAL REQUIREMENTS

SECTION 25 05 01

- .11 Bandwidth Utilization: The average utilization of the network capacity. Generally speaking the amount of present network traffic as it relates to the maximum amount of traffic for which a network can support.
- .12 Binary: A two-state system where a high signal level represents an “on” condition and an “off” condition is represented by a low signal level.
- .13 Binding: In the general sense, binding refers to the associations or mappings of the sources network variables or objects and their intended or required destinations.
 - .1 The concept of associating an output network variable from one device to the input network variable of a second (third, fourth, etc.) device.
- .14 Bridge: A device that routes messages or isolates message traffic to a particular segment, sub-net or domain of the same physical communication media.
- .15 Bus Topology: A term used to describe the sequential connection of devices on a DLN segment. The communication cable runs from device to device with no tees or stubs from the main communication cable to a device.
- .16 Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount.
- .17 Channel: A DLN network consisting of two segments connected by a physical layer repeater or router configured as a repeater.
 - .1 Each segment can support a theoretical limit of 64 connections.
- .18 Client: A device that is the requestor of services from a server.
 - .1 A client device makes requests of and receives responses from a server device.
- .19 Commissioning: A process of ensuring that systems are installed, functionally tested and capable of being operated and maintained to perform in conformity with design intent.
 - .1 Control System commissioning requires a point to point check out and the detail documentation of each parameter.
 - .2 Commissioning includes a complete functional test of the sequence of operation for each piece of equipment.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .20 Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
- .21 Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including HVAC control, switchgear, uninterruptible power supplies, lighting, security, interlocks, thermostats, EP and IP switches and like devices.
 - .1 Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operation.
- .22 Controller or Control Unit (CU): Intelligent stand-alone control panel.
- .23 Controller is a generic reference and shall include NCUs, LCUs, TCUs as appropriate.
- .24 Control Systems Server (CSS): A computer that maintains the systems configuration and programming database.
- .25 This may double as an operator workstation for smaller systems.
- .26 Deadband: A temperature or lighting range over which no heating, cooling, or lighting energy is supplied as opposed to single point changeover or overlap.
- .27 Device instance: A number that uniquely identifies a device on the Device Level Network (DLN).
- .28 Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.
- .29 Discrete: Binary or digital state.
- .30 Distributed Control: A system whereby control processing is decentralized and independent of a central computer.
- .31 Diagnostic Program: Machine-executable instructions used to detect and isolate system and component malfunctions.
- .32 DLN: Device Level Network – The local control system network that incorporates servers, control devices and software applications.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .33 EEPROM: Electrically Erasable Programmable Read-Only Memory – non-volatile, user modifiable, read-only memory that can be erased and reprogrammed repeatedly through the application of a higher than normal electrical voltage.
- .34 FAC LAN: Facility Local Area Network.
- .35 Functional Profile: A collection of variables required to define key parameters for a standard application.
 - .1 For the HVAC industry, this includes applications like VAV terminal units, fan coil units, etc.
- .36 Gateway: A device, which contains two or more dissimilar networks/protocols, permitting information exchange between dissimilar systems.
- .37 Graphical User Interface (GUI): A Man Machine Interface device (PC, laptop or dumb display terminal) which incorporates web browsing for remote network client services as a thin client machine.
 - .1 The Graphical User Interfacing allows the operator to manage, command, monitor, configure and program the system.
 - .2 It shall function as the point of interface for all control and monitoring functions as well as all data logs, trends, and alarming.
- .38 Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.
- .39 HTTP: Hypertext Transfer Protocol: the set of rules for exchanging data files (text, graphic images, sound, video and other multimedia files) over the Internet.
- .40 Integrated Automation System (IAS). The complete facility control system comprised of mechanical system automation, security control, lighting control, automatic temperature control, etc., as defined in the contract documents.
 - .1 The IAS is comprised of a tiered network structure.
 - .1 The primary tier uses Ethernet, TCP/IP protocol in a 10/100/1000 Base T wiring configuration.
 - .1 The IAS also includes interface panels, bridges, network controllers, LAN wiring, raceways, etc.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .2 All system data shall be made available to the Owner's Wide Area Network for building management.
- .3 The functionality of the system will allow building engineers the ability to view and modify the facility from any point on the Owner's WAN.
- .41 Interface Panel: A device that contains an I/O software driver to translate data from a particular format to that conforming to BACnet standards. Also see Gateway
- .42 Internet of Things (IoT): Is a concept of connecting any device to the Internet and/or to each other for the purpose of exchanging information and instructions. For the purpose of this document the network is Ethernet based utilizing IP and TCP/IP protocols and can be local (isolated) or global (Internet) or any combination of the two.
- .43 IT LAN: Reference to the facility's Information Technology network, used for normal business-related e-mail and Internet communication.
- .44 LAN: Local Area Network – a group of computers and/or associated devices which share a common communications line and typically share the resources of a single processor or server within a small geographic area.
- .45 LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the IAS.
- .46 Master Devices: Master devices can initiate requests for data but require more processing and memory capacity than slave devices.
- .47 Maximum Send Time Parameter: A parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a broadcast of the variable, a re-broadcast of the current value shall be executed. See also minimum send time parameter definitions.
- .48 Minimum Send Time Parameter: A parameter used to control unnecessary broadcasting of data onto the network. A broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also maximum send time parameter definitions.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .49 Network: A system of distributed control units and intelligent devices that are linked together on a communications bus. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location.
- .50 Network Controller Unit (NCU): A device that incorporates 1 or more network service host APIs to perform localized network management and network access services over a group of channel(s).
 - .1 Supervises groups of intelligent devices and Control Units to perform a global sequence of operation (ex: fire and life safety control).
 - .2 Can be configured to serve as a SCADA client on the IAS, Tier 1, and Local Area Network.
 - .3 Provides integration to Enterprise level systems and other protocols.
 - .4 The NCU serves four primary functions:
 - .1 Time Schedules: Time schedule algorithms shall reside in the NCU. Occupancy/energize commands shall be broadcast to the building level controllers in the number required by the sequence of control.
 - .2 Trend Data Storage: The NCU shall collect data from the building level controls at specified intervals and store the data for periodic uploading to the server. Polling communication techniques are acceptable for data collection by the network controller.
 - .3 Alarm Generation: The NCU shall receive binary alarm variables from the building level controllers and transmit this data to the alarm handling software module within the server and operator work stations. Receipt of alarm data from the building level controls shall be based on broadcasting from the building level controls and not based on polling by the Network Controller.
 - .4 Interlock and control: The network controller shall perform sequence of operation logic and control where appropriate.
- .51 Node: a Device connected to a communications network.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .52 Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.
- .53 Operator Interface (OI): A device used by the operator to manage the EMCS including OWSs, POTs, and HHDs.
- .54 Operating System (OS): Software which controls the execution of computer programs and which provides scheduling, debugging, input/output controls, accounting, compilation, storage assignment, data management, and related services.
- .55 Operator Workstation (OWS): A Man Machine Interface device (PC, laptop or display terminal) which incorporates web browsing for remote network client services.
 - .1 As the EMCS network devices are stand-alone, the OWS is not required for normal operation.
- .56 Peripheral: Input/Output equipment used to communicate to and from the computer and make hard copies of system outputs and electronic files. Peripherals include CRT, printer, hard drives, disk drives, modems, etc.
- .57 Point: Analog or discrete instrument with addressable database values.
- .58 Point-to-Point (PTP): Serial communication as defined in the BACnet standard.
- .59 Polling: The concept of a control device requesting a network variable from a second control device at a specified interval.
- .60 Polling communication is typically used to populate dynamic data on an active graphic page and for temporary or short term trending of data where the trend data is not stored at the controller level.
- .61 Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.
- .62 Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.
- .63 Repeater: A physical device used to connect two segments while amplifying, conditioning, or strengthening the signal. A Repeater does not provide any routing or filtering of network traffic.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .64 Router: A device which routes or forwards messages destined for a node on another subnet or domain of the DLN. The device controls message traffic based on node address and priority. Routers also serve as communication interfaces between power line, twisted pair and RF media.
- .65 RS-232: EIA/TIA-232 Standard
- .66 RS-485: EIA/TIA-485 Standard
- .67 Secure Socket Layer (SSL): A commonly used protocol for managing the security of messages transmission on the Internet.
- .68 Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
- .69 Simple Object Access Protocol (SOAP): A method for a program running in one type of operating system to communicate with a program on the same or different type of operating system by using the World Wide Web's Hyper Text Transfer Protocol (HTTP) and its Extensible Markup Language (XML) as the mechanisms for information exchange.
- .70 Slave Devices: Slave devices cannot initiate requests for data; they can reply only to messages from other devices. They are best suited for simple, low-cost functions.
- .71 Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable (e.g. a single relay output).
- .72 Solenoid: Electric two-position actuator.
- .73 Structured Query Language (SQL): A standard interactive and programming language for retrieving information from and for updating a database via an organized series of queries.
- .74 Stand-Alone Controller: A stand-alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller may rely on other networked devices for time schedule inputs and trend data storage.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .75 Supervisory Control And Data Acquisition (SCADA) Node: An MMI incorporating a graphical object oriented user interface software application which provides supervisory control and data acquisition from a high level processing personnel computer.
- .76 Supervisory Logic: The concept of gathering performance data from multiple terminal units to determine if a specific condition exists within the family of terminal devices.
- .77 Terminator: An electric component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communication on a segment. On a bus topology, terminators are connected to both ends of a segment. On MS/TP and free topology network segments a single terminator is required. The terminator is placed at the end-of-line for the MS/TP network segment.
- .78 Trend Log: A trend log is a collection of samples from a specified variable that are stored within a device on the IAS Network. This data may be periodically sent up to or requested by a Network Controller or an Operator Workstation for the purpose of report generation.
- .79 WAN: Wide Area Network - Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.
- .80 XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

1.9 QUALITY ASSURANCE

- .1 All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:2000 manufacturer at time of bid.
- .2 The IAS shall be furnished, engineered, installed, tested and calibrated by factory certified technicians qualified for this work. The Systems Integrator shall be Factory Authorized in good standing with the Manufacturer. Factory trained technicians shall provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .3 Upon request, installer shall present records of successful completion of factory training courses including course outlines.
- .4 Upon request the installer shall provide a letter from the manufacturer that they are Factory Authorized in good standing.
 - .1 All microprocessor based control products used shall conform to BTL Certified Standards.
- .5 For equipment types that certified devices do not exist, another interface to that equipment must be provided upon approval of the Design Team.
- .6 In addition the Owner and Design Team approval must be obtained if only proprietary control equipment is available.
- .7 The use of all proprietary equipment specified for the Integrate Automation System (IAS) integration shall be limited to devices and systems for which non-proprietary software drivers are available for the proposed Enterprise infrastructure platform.
- .8 It is the Contractor's responsibility to verify that the equipment manufacturers provide the appropriate interface boards as defined in these specifications and design drawings.
- .9 The contractor shall provide hardware and software components of the same manufacturer wherever possible.
- .10 The contractor shall use standard off-the-shelf components and/or products whenever possible. Custom products shall not be used unless approved prior to the installation.
- .11 Materials and equipment shall be catalogued products and shall be manufacturer's latest standard design that complies with the specification requirements. Where multiple units of the same type or function are required for this project, these units shall be products of a single manufacturer.
- .12 All equipment shall be manufactured, installed and tested to comply with the acceptance testing requirements specified herein.
- .13 Product Line Demonstrated History: The product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of **one (1) year** since date of final completion in at least **ten (10)** installations of comparative size and complexity.
- .14 Submittals shall document this requirement with references.

**EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01**

- .15 The IAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

1.10 IAS INSTALLER'S QUALIFICATIONS

- .1 IAS Installer to:
 - .1 Have completed at least 3 projects at Taft Union School District, and have an office staffed by trained personnel capable of providing instruction, routine maintenance, emergency service on systems,
 - .2 Not Used
 - .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after manufacturer's declaration of obsolescence.
 - .4 Have in-house staff with expertise in programming and commissioning, **programming and/or commissioning by parties other than the installing contractor is not acceptable.**

1.11 SYSTEM ARCHITECTURE

- .1 The system provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications.
- .2 The FAC LAN and DLN shall be based on industry standard open platforms as specified herein and utilize commonly available operation, management and application software.
- .3 All software packages shall be licensed to the Owner to allow unrestricted maintenance and operation of the IAS.
- .4 Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications, including but not limited to:
 - .1 Network Operating software
 - .2 Device Drivers and Plug-ins
 - .3 File Server Software
 - .4 Graphical User Interface (GUI) and Utility software

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .5 Network Management, Configuration, Controller/System Programming and Utility software.
- .6 Original electronic media and licenses for all software packages utilized to implement the IAS
- .5 The system architecture for the building IAS and consists of an Ethernet-based, wide area network (WAN), Local Area Network(s) (LAN) that supports NCUs, LCUs, TCUs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the existing IAS structure. The contractor shall utilize these components of the IAS for the scope of this project.
- .6 Facility Local Area Network (FAC LAN): The FAC LAN shall be an Ethernet-based, 10/100/1000 Ethernet LAN connecting Local NCUs, IAS server(s) as required and OWSs.
- .7 The FAC LAN serves as the backbone for the NCUs, communications path.
- .8 Contractor shall provide this as a dedicated LAN for the control system.
- .9 LAN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000 base-T gigabit Ethernet throughput.
- .10 The FAC LAN must be installed in accordance with IEEE 802.3, TIA/EIA 568-B and TIA/EIA 569-A. The FAC LAN shall support multiple NCs and OWS.
- .11 Device Level Network (DLN): Network used to connect LCUs and TCUs.
- .12 Dynamic Data Access: Data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely as defined in the point list schedules.
- .13 Remote Data Access: The system shall support the Internet Browser-based remote access to the building data.
- .14 Browser-based access: A remote/local user using a standard browser will be able access all control system facilities and graphics via the WAN or direct connection, with proper username and password.
- .1 Only Internet browser-based user interfaces HTML5 are acceptable.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .15 The Web browser software shall run on any operating system and system configuration that is supported by the Web browser.
- .16 The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface.
 - .1 Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- .17 The communication speed between the controllers, LAN interface devices, CSS, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with Shop Drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements:
 - .1 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
 - .2 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
 - .3 20 seconds between a Level 3 to 5 alarm occurrence and enunciation at operator workstation.
 - .4 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
 - .5 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
 - .6 10 seconds between a change of value or state of an input and it being updated on the operator interface.
 - .7 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least ten (10) points.
- .18 Control Systems Server (CSS): A server that maintains the systems configuration and programming database.

EMCS: GENERAL REQUIREMENTS

SECTION 25 05 01

- .1 It holds the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers.
- .2 It also acts as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information.
- .19 The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, FireFox™ or Chrome™.
- .20 The LCUs and TCUs shall monitor, control, and provide the field interface for all points specified. Each LCU, and TCU shall be capable of performing all specified energy management functions, and all DDC functions, independent of other LCUs and TCUs, and operator interface devices.
- .21 Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server that resides on the FAC LAN.
- .22 User tools for DLN and FAC LAN management shall be provided and licensed to the Owner and shall allow unrestricted configuring, updating, maintaining, and expanding of all current devices, configurations and settings.
- .23 Database Schema shall be published and provided to the Owner to facilitate easy access to DLN and FAC LAN data.
- .24 All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

1.12 BASIS OF DESIGN AND SUBSTITUTIONS

- .1 This specification is based on expanding the existing building control system, without Substitution.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

**EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01**

2.2 MANUFACTURERS

- .1 Provide a building automation system supplied by a company regularly engaged in the manufacturing and distribution of building automation systems. The BAS Manufacturer shall meet the following qualifications as a minimum:
 - .1 The manufacturer of the hardware and software components must be primarily engaged in the manufacture of building automation systems as specified herein, and must have been so for a minimum of five (5) years.
 - .2 At least 75% of the manufactured product line shall be produced under their own direction, including R&D and assembly. Rebranding of another manufacture product shall not qualify.
- .2 The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
- .3 Acceptable Manufacturers
 - .1 Controls By LPC Automation, Without substitution (888) 742-5572

2.3 MATERIALS AND EQUIPMENT

- .1 Materials shall be new, the best of their respective kinds without imperfections or blemishes, and shall not be damaged in any way.
- .2 Used equipment shall not be used in any way for the permanent installation except where Drawings or Specifications specifically allow existing materials to remain in place.

2.4 UNIFORMITY

- .1 To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

PART 3 - EXECUTION

3.1 PREPARATION

- .1 Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .2 These specifications call out certain duties of the Contractor and any subcontractor(s). They are not intended as a material list of all items required by the Contract.

3.2 INSTALLATION

- .1 Utilize licensed electricians for all new and retrofitted electrical distribution systems. Installations of high and low voltage systems shall be in accordance with all building code requirements. Obtain electrical permits, if required by local authorities.
- .2 Provide related items and work indicated on the IAS Drawings and items and work called for in this Division of the Specifications.
- .3 This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor, consumable items, fees, licenses, etc., necessary to provide complete systems.
- .4 Perform start up, configuration, programming and commissioning coordination on each control product and system to provide fully operable systems in accordance with the specified functional performance.
- .5 Comply with Federal, State, Municipal and other applicable codes and ordinances. If any conflict arises between these Specification and Drawings, and codes and ordinances, immediately notify the Owner's Representatives. Do not deviate from the Drawings and Specifications nor install any work which may be in conflict with codes and ordinances until the conflict is resolved and the solution accepted by the Owner.
- .6 The IAS Drawings show the general arrangement of the respective systems.
- .7 Follow these Drawings as closely as actual building construction and the work of other trades will permit.
- .8 Provide devices, fittings, sensors, controllers, wiring and accessories, which may be required but are not shown on the Drawings or specified herein.
- .9 The Contractor shall be responsible for achieving the sequence of operations and intent of the system design.
- .10 Investigate conditions affecting the work and arrange the work accordingly. Provide modifications and accessories as may be required to meet such conditions.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .11 All installation shall be in accordance with manufacturer's published recommendations.
- .12 Limit LAN cable lengths to no longer than 80% of the longest dimension published by the manufacturer of the cable between the most remote network nodes.

3.3 DIGITAL CONTROL PANELS, CONTROLLER QUANTITY AND LOCATION

- .1 Individual Digital Control Panels (DCPs) are referenced to indicate allocation of points to each DCP and DCP location. Digital control panels shall consist of one or multiple controllers to meet requirements of this Specification.
- .2 Where a DCP is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Contractor shall extend power to the DCP from an acceptable power panel. Furthermore, Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.
- .3 Contractor shall locate DCPs as referenced. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.
- .4 Contractor shall provide a minimum of the following:
 - .1 One DCP (including at least one controller) for each air handler located in applicable mechanical room
 - .2 One DCP (including at least one controller) for each critical fan system
 - .3 One DCP (including at least one controller) for each CRAC system
 - .4 One DCP (including at least one controller) for each ATS
 - .5 One DCP (including at least one controller) for each lighting system
 - .6 One DCP (including at least one controller) for each stair pressurization fan system
 - .7 One controller for each piece of terminal equipment, to be located at the equipment (e.g. VAV box).

3.4 NETWORK MANAGEMENT FUNCTIONAL REQUIREMENTS

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .1 The Contractor shall coordinate the setup and configuration of the IAS local area network hardware to permit the functional requirements of the IAS herein specified. The setup shall include as a minimum the following network management procedures:
 - .1 Automatic backup of the DDC System database to appropriate media.
 - .2 Program, load and debug all software installations.
 - .3 Network user auditing routine.

3.5 SURGE PROTECTION

- .1 Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all NCs, operator interfaces, printers, routers and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.6 CONTROL POWER SOURCE AND SUPPLY

- .1 IAS Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Division 25 and the Drawings.
- .2 General requirements for obtaining power include the following:
 - .1 In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 480V or 600V source, obtain power from the electrically most proximate 120v source fed from a common origin.
 - .2 Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source of power as the equipment. If the equipment's control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, or is too noisy for reliable control, provide a separate transformer.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .3 Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served.

3.7 PRODUCT DELIVERY, STORAGE, HANDLING, PROTECTION AND CLEANING

- .1 All products and materials shall be new, clean, and free of defects, damage and corrosion.
- .2 Ship and store products and materials in a manner which will protect them from damage, weather, and entry of debris. Do not install damaged items - take immediate steps to obtain replacement or repair.
- .3 The Contractor shall provide adequate means for and shall fully protect all finish parts of the materials and equipment against damage from any cause during the progress of the work until final acceptance. All materials and equipment in storage and during construction shall be covered in such a manner that no finished surfaces will be damaged or marred, and all moving parts shall be kept clean and dry. The Contractor is responsible for providing storage of materials and equipment.
- .4 Equipment and accessories shall be thoroughly cleaned of cement, plaster, and other materials; grease and oil spots shall be removed with cleaning solvent and surfaces carefully wiped.
- .5 Panels housing electronic controllers shall be constructed so that the panel and associated wiring may be installed independent of the installation of the electronics. The installation of electronics shall be coordinated with other trades and construction schedules to avoid damage.

3.8 SITE CLEAN UP

- .1 At conclusion of each day's work, clean up and remove from the site all rubbish, debris and trash accumulated during the day as a result of work of the Contractor. Sidewalks and streets adjoining the property shall be kept broom clean and free of debris, rubbish, trash and obstructions of any kind caused by work of this Contract.
- .2 Upon completion of the work and at times during progress of the work when requested by the Owner, the Contractor shall remove all surplus materials, rubbish, and debris resulting from the operation, and shall leave the entire building and involved portions of the site, insofar as the work of the Contract is concerned, in neat, clean and acceptable condition as approved by Owner.

EMCS: GENERAL REQUIREMENTS
SECTION 25 05 01

- .3 Marks on walls or ceiling tiles caused by the Contractor shall be cleaned by the Contractor. Ceiling tiles, drywall, carpet, paint, and all architectural finishes damaged by the Contractor shall be replaced by the Contractor.

END OF SECTION

EMCS: Submittals and Review Process
SECTION 25 05 02

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes.
 - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section [25 05 01 - EMCS: General Requirements].

1.3 SUBMITTALS

- .1 General: Submit Two (2) copies of the materials to be delivered directly to Owner's representatives.
 - .1 In addition, an electronic version of the completed materials shall be provided on electronic media.
 - .2 Data can be in native file format or scanned where necessary.
- .2 Functional Intent: Throughout the Contract Documents, detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement.
 - .1 Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent.
 - .1 These will only be allowed with prior approval.
- .3 Electronic Submittals: While all requirements for hard copy submittal apply, IAS control submittals and operation and maintenance (O&M) information shall also be provided in electronic format as follows:
- .4 Drawings and Diagrams: Shop Drawings shall be provided on electronic media as an AutoCAD drawing per Owner's CAD standards. All 'x reference' and font files must be provided with AutoCAD files.
- .5 Other Submittals: All other submittals shall be provided in Adobe Portable Document Format
- .6 Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate items.

EMCS: Submittals and Review Process
SECTION 25 05 02

- .1 Submit a list of no less than five similar projects, which utilize the Enterprise connectivity to provide an Integrated Automation System that consists of web-browser control and monitoring of the proposed field level devices.
 - .1 These projects must be on-line and functional such that representatives from the Owner can observe the Integrated Automation System and Interface in full operation. Include proper references and contact numbers of these reference projects.
- .2 Submit validation which indicates the successful completion of the required certification course(s).
- .3 Submit resumes of installing staff indicating passing certificates for training on the line of controls to be installed as part of this project. Also include prior Instrumentation and Control experience.
- .4 Submit an organizational diagram indicating the key technical staff proposed for the project including Project Manager, Application Engineer, Programmers, Superintendent, Electrical Foreman, Electricians, and Technicians etc.
- .5 Provide staff quantities to be assigned to the project. Provide contact information for Managers, Programmers, and Lead Technicians upon acceptance of bid.
- .6 Submit a record of the number of personal employed by the System Integrator.
- .7 This submittal shall clearly indicate the number of managers, technicians, electricians, and programmers certified in the line of DDC controls represented and certified in graphical user interface development and system network management.
- .8 Also indicate the number of staff that will be assigned to this project.
- .9 Provide certifications of all employed personal trained and certified by an Enterprise Network Infrastructure manufacturer for GUI integration and development.
- .10 Identify the number of integrators to be assigned to this project.
- .11 The Contractor shall indicate the duration, in which the company has represented the line of controls proposed for this project.

EMCS: Submittals and Review Process
SECTION 25 05 02

- .12 The Contractor shall also disclose all previous manufactures that have been or currently are represented over the last seven (7) years.
- .13 GUI development software
 - .1 Provide screen captures of graphical user interfaces developed by the Contractor on previous projects. These screen shots shall represent work performed by the contractor and not of the company from the line of controls which the Contractor represents. Provide client contact information for the Owner to validate.
- .7 Product Data: Submit manufacturer's technical product data for each Network Control Unit, control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.
- .8 Products: Within twenty one (21) days after date of execution of General Contractor/Sub-Contractor agreement, submit for acceptance a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom the Contractor proposes to employ.
 - .1 Provide a list of devices in schedule form on 8½ x 11 sheets. The schedule shall be organized by columns to define all new devices to be installed as part of the EMCS system including the location, system served, controlling unit, model number, performance data, size, range, accuracy, span, operating pressure, etc.
 - .2 Submit documentation indicating BTL compliance and include Protocol Implementation Conformance (PIC) Statements. All PIC statements, product literature, and standard configuration parameters shall be compiled and submitted on electronic media, in addition to providing hard copies.
 - .1 Network Controllers
 - .2 Intelligent Sensors and Actuators
 - .3 Application Specific Controllers
 - .4 Local Control Units
 - .5 Terminal Control Units.
 - .6 Interface Panels

EMCS: Submittals and Review Process
SECTION 25 05 02

- .7 Network Management Equipment (Routers, Protocol Analyzers, etc.)
- .3 Submit detailed cut sheets indicating the features, accessories and sub-assemblies of the following, or similar as required:
 - .1 All ancillary devices including temperature sensors, flow sensors, and the like, including thermal wells where necessary
 - .1 Pressure gauges, thermometers and indicating devices where shown on the drawings
 - .2 Transformers required for control devices
 - .3 Relays
 - .4 Electrical enclosures and back-plates
 - .5 Wire for DLN, FAC LAN, and all sensors and actuators
 - .6 FAC LAN Hub(s), Switches, and Routers
 - .7 DLN Repeaters
 - .8 Gateway and interface devices
 - .9 Network Management Utility Software
 - .10 Application Programming Tools/Software (DDC controller programming software)
 - .11 Interface devices.
 - .12 Web based configuration and programming for control devices
- .4 Submit Shop Drawings for each control system, including a complete drawing for each controller identified in the IAS drawings with all point descriptors, addresses and point names indicated. Include mounting details and power supplies. Shop Drawings shall contain the following information:
 - .1 System Architecture and System Layout:
 - .1 One-line diagram indicating how the new network controller units will integrate with the IAS field level devices.

EMCS: Submittals and Review Process
SECTION 25 05 02

- .2 Provide floor plans locating all NCUs, LCUs and TCUs, workstations, servers, LAN interface devices, etc.
 - .3 Include all WAN, FAC LAN and DLN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, MAC address, device instance, drawing reference number, and controller type for each NCU.
 - .4 Indicate media, protocol, baud rate, and type of each FAC LAN segment.
 - .5 All controllers, sensors located in finished areas, I/O devices installed in mechanical systems, repeaters, end-of-line resistors, other IAS related components, sensors and actuators, etc. shall be located on the floor plans.
 - .6 Wiring routing and as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately to reflect actual installed conditions.
 - .7 Schematic flow diagram of each air system showing fans, coils, dampers, valves, and control devices. Include written description of sequence of operation.
 - .8 All physical and logical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses as identified in the point list schedule.
-
- .2 With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). If this information is not available at the time of Shop Drawings submittals, furnish with O&M manual documentation for Owner review and approval. See Section 25 15 00 for additional requirements.
 - .3 Label each control device with setting or adjustable range of control.
 - .4 Label each input and output with the appropriate range.

EMCS: Submittals and Review Process
SECTION 25 05 02

- .5 Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.
- .6 With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers
- .7 Provide detailed schematics for interface connections including installation and commissioning specifics. Include detailed terminal interconnect diagrams for connecting to equipment manufacture's integral communications boards.
- .8 Indicate all required electrical wiring.
- .9 Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified.
- .10 Provide panel termination details on separate Drawings. Ladder diagrams shall appear on system schematic.
- .11 Clearly differentiate between portions of wiring that exists, factory-installed and portions to be field-installed.
- .12 Provide details for wiring color code assignment.
- .13 Provide details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
- .14 Sheets shall be consecutively numbered.
- .15 Each sheet shall have a title indicating the type of information included and the system type controlled.
- .16 Table of Contents listing sheet titles and sheet numbers.
- .17 Legend and list of abbreviations
- .18 Submit in Schedule format a detailed list of all spare parts to be provided per the contract documents.
- .19 Provide User Interface Graphic Screens as defined in 25 15 00 including:

EMCS: Submittals and Review Process
SECTION 25 05 02

- .1 Proposed method of Navigation
- .2 Summary
- .3 Floor Plans
- .4 Trends
- .5 Alarms

1.4 CONTROL LOGIC DOCUMENTATION

- .1 Submit control logic program listings of graphical programming to document the control software of all control units.
- .2 Submit functional temperature control diagrams for each mechanical system served by the IAS. Indicate and tag each input/output served by each LCU and TCU and show locations and functions of ISA's.
- .3 Submit logical control diagram indicating each node, node address, Network Variables in and out of each node including message bindings.
- .4 Include written description of each control sequence.
- .5 Include control response, settings, and setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits as part of as-built documentation.
- .6 Sheets shall be consecutively numbered.
- .7 Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
- .8 Include Table of Contents listing sheet titles and sheet numbers.
- .9 Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below and in Division 01.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section [01 33 00 - Submittal Procedures] and coordinate with requirements in this Section.
- .2 Submit a preliminary design document within [5] working days after contract award, for review by Taft Union High School District, Factory Authorized DDC Contractor .

EMCS: Submittals and Review Process
SECTION 25 05 02

1.6 SUBMISSION QUALITY ASSURANCE

- .1 Preliminary Design Review Meeting: Convene meeting within [45] working days of award of contract to:
 - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
 - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
 - .3 Review interface requirements of materials supplied by others.
 - .4 Review "Sequence of Operations".
 - .5 Contractor's programmer to attend meeting.
 - .6 Taft Union High School District, Factory Authorized DDC Contractor retains right to revise sequence or subsequent CDL prior to software finalization without cost to Taft Union High School District, Factory Authorized DDC Contractor .

END OF SECTION

EMCS: Project Record Documents
SECTION 25 05 03

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 10 01, EMCS: Networks
- .5 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .6 SECTION 25 30 01, EMCS: Field Controllers
- .7 SECTION 25 35 13, EMCS: Actuators and Operators
- .8 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .9 SECTION 25 35 19, EMCS: Control Valves
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 RECORD DOCUMENTS:

- .1 Provide record copies of product data and control Shop Drawings updated to reflect the final installed condition.
- .2 Provide record copies of approved control logic programming and database on paper and on electronic media. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of Shop Drawings and including changes to programs made during specified testing.
- .3 Provide record copies of approved Project specific graphic software on electronic media.

EMCS: Project Record Documents
SECTION 25 05 03

- .4 Provide as-built network architecture Drawings showing all nodes including a description field with specific controller identification, description and location information.
- .5 Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, logical address and drawing reference number.
- .6 Provide record riser diagram showing the location of all controllers.
- .7 Maintain Project record documents throughout the Warranty Period and submit final documents at the end of the Warranty Period.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .6 SECTION 25 30 01, EMCS: Field Controllers
- .7 SECTION 25 35 13, EMCS: Actuators and Operators
- .8 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .9 SECTION 25 35 19, EMCS: Control Valves
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 NETWORKS

- .1 The EMCS network(s) must be based on Open Systems.
- .2 Industry standard IP switches, routers and other network devices as required shall be used at the network level as the manager(s).
- .3 The resulting network will be a 'Flat' topology with all devices (controllers, workstations, ...) connecting at the same physical network level
- .4 High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices.

EMCS: Networks
SECTION 25 10 01

- .5 Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.
- .6 Detection and accommodation of single or multiple failures of workstations, controller panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
- .7 Message and alarm buffering to prevent information from being lost.
- .8 Error detection, correction, and retransmission to guarantee data integrity.
- .9 Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
- .10 Commonly available, multiple sourced, networking components shall be used to allow the system to coexist with other networking applications such as office automation. Ethernet to IEEE 802.3 standard is the only acceptable technology.
- .11 Synchronization of the real-time clocks in all NCU panels shall be provided.
- .12 The EMCS network shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, SOAP, OBIX, SNMP and SMTP Protocols for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Control Units (NCUs), user workstations and where specified, a local server. Local area network minimum physical and media access requirements:
 - .1 Ethernet; IEEE standard 802.3
 - .2 Cable; 100 Base-T, UTP-8 wire, category 5 minimum
 - .3 Minimum throughput; 100 Mbps
- .13 Provide access to the EMCS network via a Wireless Application Protocol (WAP) device. Through this connection the EMCS network will provide authorized staff with the ability to monitor and control the EMCS from any location within the through a web browser, cellular phone, pager, web-enabled media players, or PDA (Pocket Computer).

EMCS: Networks
SECTION 25 10 01

- .14 Provide access to the EMCS network from a remote location, via the Intranet or Internet. The owner shall provide a connection to the Internet to enable access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or access to an Internet Service Provider (ISP). If required, the owner will provide a switch/firewall between the building LAN and the EMCS network. Through this connection the EMCS network will provide authorized staff with the ability to monitor and control the EMCS from a remote location through a web browser, cellular phone, pager, web-enabled media players, or PDA. (Pocket Computer).

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Data communications equipment necessary to achieve an EMCS data transmission system including LAN hardware and software for a BACnet® system
- .2 Software complete with full documentation for software and equipment.

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATION

- .1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 GENERAL WORKMANSHIP

- .1 Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- .3 Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- .4 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- .5 Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.3 FIELD QUALITY CONTROL

EMCS: Networks
SECTION 25 10 01

- .1 Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.
- .2 Continually monitor field installation for code compliance and workmanship quality.
- .3 Contractor shall arrange for work inspection by authorities having jurisdiction over the work.

3.4 COMMUNICATIONS WIRING

- .1 Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
- .2 Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
- .3 During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- .4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .5 Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- .6 Each run of communication wiring shall be a continuous length without splices when that length is commercially available.
 - .1 Runs that are longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- .7 Label communication wiring to indicate origination and destination.
- .8 Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.5 FIBER OPTIC CABLE

- .1 Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 μm .
- .2 Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

EMCS: Networks
SECTION 25 10 01

- .3 During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- .4 Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable andunjacketed fiber bend radii specified by cable manufacturer.

END OF SECTION

EMCS: Computer Systems, MMI
SECTION 25 10 02

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 30 01, EMCS: Field Controllers
- .7 SECTION 25 35 13, EMCS: Actuators and Operators
- .8 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .9 SECTION 25 35 19, EMCS: Control Valves
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 GENERAL DESCRIPTION:

- .1 The computer shall consist of commercially available general-purpose equipment manufactured by a recognized manufacturer with factory authorized service centers within 25 miles of the job site.
- .2 The server shall be provided for centralized system control, information management, alarm management and data base management functions.
- .3 All real time control functions shall be resident in the standalone Network Control Unit (NCU) and local controllers (LCUs and TCUs).
- .4 Provide a Server as detailed herein complete with software.
- .5 Provide Operator workstations as detailed herein complete with software.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .6 The system shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users. The EMCS shall be provided with a minimum of 32 user licenses.
- .7 Provide three copies of all Programming Software required for programming LCUs and TCUs as described herein.
- .8 Any computer with access to the EMCS LAN shall be capable of displaying the systems in a graphical and dynamic format utilizing a standard web browser. Screen refresh shall be automatic. Manual refresh is not acceptable

PART 2 - PRODUCTS

2.1 SERVER HARDWARE REQUIREMENTS

- .1 The Server shall be a PC with minimum Intel Core i5 Quad core 3.4 GHz processor with 8 GB RAM and a 1TB SATA hard drive with 6 GB/s transfer rate. It shall include a minimum 32X CD-ROM drive and 4-USB 3.0 ports. A minimum 21", HDMI, DVI-D video interfaces, minimum 1024 x 768 resolution, 4x3 Widescreen, LED color monitor with a minimum 60 Hz refresh rate shall also be included.
- .2 The server operating system
 - .1 shall be one of:
 - .1 Windows 7 Professional 64bit
 - .2 Windows 8.1 64bit
 - .3 Windows Server 2012 64bit
 - .4 Windows 10 Pro 64bit
 - .5 Windows 10 Enterprise 64bit
 - .2 With VM support
 - .3 With the most recent service packs and system updates.
 - .4 Selected based on availability and project requirements.
- .3 Latest version of Symantec Antivirus Software that includes a 3 year subscription service to the Symantec software.
- .4 Acceptable Manufacturers are:
 - .1 Dell

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .2 Lenovo
- .3 HP (Hewlett Packard)
- .5 Connection to the EMCS LAN network shall be via an Ethernet network interface card, 100 Mbps.
- .6 The server is existing.
- .7 The server shall support all Network Control Units (NCU), OWSs, and 3rd party mechanical / electrical systems connected to the Facility Management Control / Building Automation System Local Area Network.

2.2 UNINTERRUPTIBLE POWER SUPPLIES

- .1 Provide the OWS, Server, and each NCU with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to 15 minutes duration.
- .2 Acceptable Manufacturer is APC.

2.3 OPERATOR SOFTWARE (MAN MACHINE INTERFACE) MMI

- .1 Operating System: See Sections 2.2 and 2.3 for specific OSs.
- .2 The software shall employ browser-like functionality for ease of navigation.
 - .1 It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database.
 - .2 In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills.
 - .1 These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- .3 Tagging.
 - .1 An alternate Identification mechanism for advanced or simple query of the ECMS system.
- .4 Real-Time Displays.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .1 Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
 - .1 Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.
 - .2 The graphic shall provide for the ability to command each point, including both timed and permanent overrides.
 - .3 Provide for all information represented in the graphics in an associated graphical table with links to the equipment graphics and command-able points.
 - .4 Sample graphics shall be provided as part of the submittals for approval by owner.
- .5 The Operator software, shall at a minimum, support the following graphical features and functions:
 - .1 Graphic screens shall be developed using GIF, PNG, JPG or ICO file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
 - .2 Graphic screens shall have the capability to contain objects for text, real-time values, animation, colour spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
 - .3 Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
- .6 Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - .1 Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - .2 Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
- .7 Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .8 Right-clicking the selected object and using a graphical slider to adjust the value shall make adjustments to analog objects, such as set points. No entry of text shall be required.
- .9 System Configuration.
 - .1 At a minimum, the Operator software shall permit the operator to perform the following tasks, with proper password access:
 - .1 Create, delete or modify control strategies.
 - .2 Add/delete objects to the system.
 - .3 Tune control loops through the adjustment of control loop parameters.
 - .4 Enable or disable control strategies.
 - .5 Generate hard copy records or control strategies on a printer.
 - .6 Select points to be alarm-able and define the alarm state.
 - .7 Select points to be trended over a period of time and initiate the recording of values automatically.
- .10 On-Line Help.
 - .1 Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.
 - .1 On-line help shall be available for all applications and shall provide the relevant data for that particular screen.
 - .2 Additional help information shall be available through the use of hypertext.
 - .3 All system documentation and help files shall be in HTML format.
- .11 Security.
 - .1 Each operator shall be required to log on to that system with a user name and password in order to view, edit add, or delete data.
 - .2 System security shall be selectable for each operator.
 - .3 The system administrator shall have the ability to set passwords and security levels for all other operators.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .4 Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
- .5 Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
- .6 This auto log-off time shall be set per operator password.
- .7 All system security data shall be stored in an encrypted format.
- .12 System Diagnostics.
 - .1 The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
 - .2 The failure of any device shall be annunciate to the operator.
- .13 Alarm Console.
 - .1 The system shall be provided with a dedicated alarm window or console.
 - .1 This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
 - .2 The use of the Alarm Console can be enabled or disabled by the system administrator.
 - .1 When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator.
 - .3 This window will notify the operator of new alarms and un-acknowledged alarms.
 - .4 Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
- .14 Operator's software shall contain an easy-to-operate system; allowing configuration of system-wide controllers, including management and display of the controller programming.
 - .1 This system shall provide the capability to configure controller binary and analog inputs/outputs.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .15 The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.
 - .1 Graphics generation shall be done using standard Windows packages.
 - .2 No proprietary graphics generation software shall be needed.
- .16 Provide software, which enables the non-programmer operator to easily perform, tasks which are likely to be part of his daily routine.
- .17 The operator's console shall provide facilities for manual entries and visual displays enabling an operator to enter information into the system and obtain displays and logs of system information.
 - .1 All requests for status, analog, graphic displays, logs, and control shall be selected from the operator's console.
 - .2 The operator interface shall minimize the use of typewriter style keyboard by implementing a mouse or similar pointing device and "point and click" approach to command selection.
 - .3 The facility shall be provided to permit the operator to perform the following tasks:
 - .1 Automatic logging of digital alarms and change of status message.
 - .2 Automatic logging of all analog alarms.
 - .3 System changes (alarm limits, set-points, alarm lock-outs, etc.).
 - .4 Display specific points as requested by the operator.
 - .5 Provide reports as requested by the operator and on Scheduled basis where so required.
 - .6 Display graphics as requested by the operator.
 - .7 Display of help information.
 - .8 Provide trend logs as required by the operator.
 - .9 Provide manual control of digital and analog outputs as required by the operator.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .10 Direct the hard copy output of information to the device selected by the operator.
- .11 Data displayed on monitor to cyclic update as appropriate.
- .18 Online changes:
 - .1 Alarm limits.
 - .2 Setpoints.
 - .3 Dead-bands
 - .4 Changes/deletions/additions of points.
 - .5 Control and change of state changes.
 - .6 Time of day, day, month, year.
 - .7 Control loop control description changes for NCU based CDM's.
 - .8 Control loop tuning changes
 - .9 Schedule changes
 - .10 Changes/additions/deletions to system graphics
 - .11 Changes/additions/deletions to total systems
- .19 It shall be possible for the operator to override automatic analog and digital output commands.
 - .1 Where the EMCS software normally originates these outputs, the provision shall exist for the operator to terminate automatic EMCS control of any particular output and to originate a manual analog or digital output command.
 - .2 The provision shall exist for the operator to return analog or digital output command functions to automatic EMCS software control.
 - .3 It shall be possible for the operator to place any computed system setpoint to a computed basis as and when required.
 - .4 All above functions shall operate under the password protection system.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .20 A vocabulary of at least 25 different descriptions using at least six alphanumeric characters to identify engineering units for analog input and output points. Typical description is as follows: %, °C, KPA, KW, KWH, L/S, CFM, °F, and PSI.
 - .1 The descriptions shall be alterable from the OWS console with the system on-line.
- .21 Upon operator's request, the system shall present the condition of any single point, any system, and area or the whole system on printer or Monitor.
 - .1 The output device shall be by operator's choice.
 - .2 Analog values and status displayed on the Monitor shall be updated whenever new values are received.
 - .3 Points in alarm shall be flagged by blinking, inverse video different colour, bracketed, or by some other means to differentiate them from points not in alarm.
- .22 Error Messages
 - .1 Inform operator of all errors in data, errors in entry instructions, failure of equipment to respond to requests or commands, or failure of communications between components of EMCS.
 - .2 Error messages to be comprehensive and communicate clearly to operator precise nature of problem.
- .23 Password Protection
 - .1 Provide security system that prevents unauthorized use unless operator is logged on.
 - .1 Access shall be limited to operator's terminal functions unless user is logged on, including displays as outlined above.
 - .2 Each operator's workstation shall provide security for 100 users minimum.
 - .1 Each user shall have an individual User ID, User Name and Password.
 - .2 Entries are alphanumeric characters only and are case sensitive (except for User ID).

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .3 User ID shall be 8 characters,
- .4 User Name shall be a maximum of 29 characters, and Password shall be a maximum of 8 characters long.
- .5 Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access.
- .6 All passwords, user names, and access assignments shall be adjustable online at the operator's terminal.
- .7 Each user shall also have a set security level, which defines access to displays and individual objects the user may control.
- .8 System shall include 10 separate and distinct security levels for assignment to users.

.24 Trend Data

- .1 System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.
 - .1 Archived files shall be appended with new sample data, allowing samples to be accumulated over **3** years.
 - .2 Systems that write over archived data shall not be allowed, unless limited file size is specified.
 - .3 Samples may be viewed at the operator's terminal in a trend log.
 - .4 Logged data shall be stored in spreadsheet format.
 - .5 Operator shall be able to scroll through all trend log data.
 - .6 System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically.
 - .7 All trend log information shall be displayed in standard engineering units.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .2 Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colours and these Graphs shall show object type value relative to time.
- .3 Operator shall be able to change trend log setup information.
 - .1 This includes the information to be logged as well as the interval at which it is to be logged.
 - .1 Minimum interval of 1 minute.
 - .2 All input, output, and value object types in the system may be logged.
 - .3 All operations shall be password protected.
 - .4 Setup and viewing may be accessed directly from any and all graphics object is displayed on.
- .4 System shall be capable of periodically gathering energy log data stored in the field equipment and archive the information on the operator workstation's hard disk.
 - .1 Archive files shall be appended with the new data, allowing data to be accumulated over several years.
 - .2 Systems that write over archived data shall not be allowed unless limited file size is specified.
 - .3 System shall automatically open archive files as needed to display archived data when operator scrolls through the data.
 - .4 Display all energy log information in standard engineering units.
- .5 System software shall be provided that is capable of graphing the energy log data. Software shall be capable of creating two-axis (x,y) graph that show recorded data, relative to time.
 - .1 All data shall be stored in spreadsheet format for direct use by third-party spreadsheet or other database programs.
 - .2 Operation of system shall not be affected by this operation.
- .6 Operator shall be able to change the energy log setup information.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .1 Including the meters to be logged, meter pulse value, and the type of energy units to be logged.
- .2 All meters monitored by the system may be logged.
- .3 All operations shall be password protected.

.25 Graphics

- .1 The operator's workstation shall display all data associated with the project.
 - .1 The operator's terminal software shall accept, GIF, PNG, JPG and ICO format graphic files for display purposes.
 - .2 Graphic files shall be created using scanned, full colour photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings.
 - .3 Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.
 - .4 Displays can be used as templates to produce other displays
- .2 System shall be capable of displaying graphic file, text, and dynamic object data together on each display.
 - .1 Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.
 - .2 All information on any display shall be dynamically updated without any action by the user.
 - .3 Terminal shall allow user to change all field-resident EMCS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.
 - .4 This shall be done without any reference to object addresses or other numeric/mnemonic indications.
- .3 All displays shall be generated and customized in such a manner by the local DDC system supplier that they fit the project as specified.
 - .1 Canned displays shall not be acceptable.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .2 Displays shall use Standard English for labelling and readout.
- .3 Systems requiring factory programming for graphics are specifically prohibited.
- .4 The installing contractor without factory dependency or assistance shall support all graphics and DDC programming locally.
- .4 Binary objects shall be displayed as ON/OFF/NULL or with customized text.
 - .1 Text shall be justified left, right or centre as selected by the user.
 - .2 Allow binary objects to be displayed as individual change-of-state bitmap objects on the display screen such that they overlay the system graphic.
 - .3 Each binary object displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm.
 - .4 For binary outputs, toggle the objects commanded status when the bitmap is selected with the system digitizer (mouse). Similarly, allow the terminal operator to toggle the object's status by selecting (with the mouse) a picture of a switch or light, for example, which then displays a different picture (such as an ON switch or lighted lamp).
 - .5 Additionally, allow binary objects to be displayed as an animated graphic.
- .5 Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
 - .1 For example: when a pump is in the OFF condition, display a stationary picture of the pump. When the operator selects the pump picture with the mouse, the represented objects status is toggled and the picture of the pumps impeller rotates in a time-based animation.
 - .2 The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF.
 - .3 Allow operator to change bitmap file assignment and also create new and original bitmaps online.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .4 System shall be supplied with a library of standard bitmaps, which may be used unaltered or modified by the operator.
- .5 Systems that do not allow customisation or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.
- .6 Analog objects shall be displayed with operator modifiable units.
 - .1 Analog input objects may also be displayed as individual bitmap items on the display screen as an overlay to the system graphic.
 - .2 Each analog input object may be assigned to a minimum of five bitmap files, each with high/low limits for automatic selection and display of the bitmaps.
 - .3 As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint.
 - .4 Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box.
 - .5 Selection for display type shall be individual for each object.
 - .6 Analog object values may be changed by selecting either the increase or decrease arrow in the analog object spinner box without using the keypad.
- .7 Analog objects may also be assigned to an area of a system graphic, where the colour of the defined area would change based on the analog objects value.
 - .1 For example, an area of a floor-plan graphic served by a single control zone would change colour with respect to the temperature of the zone or its deviation from setpoint.
 - .2 All editing and area assignment shall be created or modified online using simple icon tools.
- .8 A customized menu label (push-button) shall be used for display selection.
 - .1 Menu items on a display shall allow penetration to lower level displays or additional menus.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .2 Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item.
- .3 Each display may be protected from viewing unless operator has appropriate security level.
- .4 A separate security level may be assigned to each display and system object.
- .9 A mouse, or other form of digitizer, shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.
- .10 Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
 - .1 The presentation will contain displays for:
 - .1 Site Overview
 - .2 Specific Building(s)
 - .3 Floor plates within Building(s)
 - .4 Each controlled Zone
 - .5 Each controlled System or Sub-System
 - .2 All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
 - .1 Clicking on a building in the Site Overview displays the specific building display.
 - .2 Clicking on a floor, displays the floor plate display
 - .3 Clicking on a zone, displays the specific control system for that zone.
 - .4 Clicking on a specific system or sub-system coarse representation at the floor plate display level displays a detailed presentation of the system or sub-system.
- .11 Displays are stored on the server and may be modified on site or via remote communications.
- .12 Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.

EMCS: Computer Systems, MMI
SECTION 25 10 02

.26 Alarms

- .1 Operator's terminal shall provide audible, visual, electronic and printed means of alarm indication.
- .2 Any alarm may be handled based on its individual or assigned class actions.
 - .1 Actions are, but not limited to
 - .1 Displayed on the Alarm console.
 - .1 The system shall be provided with a dedicated alarm window or console.
 - .2 This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
 - .3 The use of the Alarm Console can be enabled or disabled by the system administrator.
 - .4 When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator.
 - .5 This window will notify the operator of new alarms and un-acknowledged alarms.
 - .6 Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
 - .7 Printout of alarms shall be sent to the assigned terminal and port.
 - .2 Delivery by electronic mail (e-mail).
 - .1 Sent via e-mail to one or more recipients.
 - .3 Printed.
 - .1 Printed on local or network printer
- .3 System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .1 Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.
- .4 Alarm messages shall be in user-definable text English or other specified language) and shall be entered either at the operator's terminal or via remote communication.

.27 Scheduling

- .1 Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
 - .1 This includes all ON/OFF times (to the minute) for each day's events.
- .2 Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
 - .1 These speciality schedules shall be displayed at the operator's terminal in a format similar to the weekly schedules, again allowing easy data entry.
 - .2 Exception schedule data is entered by the following methods:
 - .1 date entries (one day entries)
 - .2 date-to-date (a range or span of days)
 - .3 by weekday (for example, a given day of a given week each month)
 - .3 User shall be able to scroll easily through the months for each year as a minimum.
- .3 At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

.28 Archiving

- .1 Store back-up copies of all controller databases in at least one OWS and the server.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .2 Provide continuous supervision of integrity of all controller databases.
 - .1 Data base back up and downloading to occur over LAN without operator intervention.
- .3 Operator to be able to manually download entire controller database or parts thereof.

.29 Reports

- .1 Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
 - .1 If display output (Monitor) is requested, it shall be scrollable; scroll bars will be used to allow easy and flexible movement within the report.
 - .2 Output to be sorted by area, system point.
- .2 Periodic/Automatic Report:
 - .1 Provide the software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
 - .2 The software will allow the operator to modify the periodic/automatic reporting profile at any time.
- .3 As a minimum, the following reports shall be configured on the system:
 - .1 Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency and it shall be possible to select points on the following basis:
 - .1 All points in all areas
 - .2 Area (all points in area)
 - .3 Area system (all points in system)
 - .4 Area system point (individual point)
 - .5 System (all points by system and point type)

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .6 System point (all points by system and point type)
- .7 Area point (all points by area and point type).
- .2 Summary Report:
 - .1 To permit the display or printing of the dynamic values for the user specified points.
 - .1 Reports to be available on same basis as dynamic reports.
 - .2 Output will be to the user selected output device.
- .3 Trend Reports:
 - .1 To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
- .4 Historical Data Collection:
 - .1 Provision shall be made to ensure historical data is not lost.
 - .1 The ability to off-load historical data to removable media, and to later load data previously backed-up, will be provided.
 - .2 Historical data values, for an operator specified time range and for operator specified points, may be output the same as for trend data.
- .5 Critical Alarm Summary:
 - .1 Provide a summary of those points in the critical alarm state and include as a minimum; point acronym, point description, alarm type, limit exceed, current value, alarm type, time and date of occurrence.
- .6 Maintenance Alarm Summary:
 - .1 Provide a summary of those points in maintenance alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceed, time and date of occurrence.
- .7 Alarm Summary:

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .1 Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
- .8 Disable Point Summary:
 - .1 Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
- .9 Run Time Summary:
 - .1 Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
- .10 Schedule Summary:
 - .1 Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
- .11 User Record Summary:
 - .1 Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.
- .30 LCU / TCU Programming Software
 - .1 Provide programming software for the Local Control Unit (LCU) and the Terminal Control Unit (TCU) that allows for the development of the LCU/TCU control logic and point management and Graphical User Interface screens.
 - .1 A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens.
 - .2 Access to these functions shall be provided through Graphical User Interface software (GUI).

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .3 Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool.
- .4 Completed applications may be stored in the library for future use.
- .5 Graphical User Interface screens shall be created in the same fashion.
- .6 Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates.
- .7 Any real-time data value or object property may be connected to display its current value on a user display.
- .8 Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- .9 Programming Methods:
 - .1 Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application.
 - .2 Objects shall be linked by a graphical linking scheme by dragging a link from one object to another.
 - .3 Object links will support one-to-one, many-to-one, or one-to-many relationships.
 - .4 Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
- .10 Object Configuration
 - .1 Each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons.
 - .2 Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .11 The software shall provide the ability to view the logic with values being inputted to and outputted from the graphical blocks in real time. (debug mode)
 - .12 The system shall support object duplication within a client's database.
 - .1 An application, once configured, can be copied and pasted for easy re-use and duplication.
 - .2 All links, other than to the hardware, shall be maintained during duplication.
 - .13 Provides function to compare and calculate from multiple values from networked controllers (NCU, TCU and/or LCU).
 - .14 As a minimum, the function shall calculate and compared the values and return the average, sum, highest, lowest, 3 highest, 3 lowest values and multi-state value count.
 - .15 Auto-linking of objects to graphics
 - .16 [Can include] Auto-Encapsulate functionality (the automatic ability to group multiple programming objects into a new singular programming object).
 - .17 Allow for uploading/downloading to/from multiple controllers
- .31 Utility Software
- .1 Supply and install software products to allow the owner to access and manipulate the control schematic diagrams, and to access product data sheets in an electronic format.
 - .2 Enter all soft copy submissions; including "Record" drawings as specified herein Shop Drawings, Product Data and Review Process in OWS.

2.4 NATIVE WEB BROWSER INTERFACE

- .1 The contractor shall provide web-browser delivered graphical visualization software as part of the operator workstation, server, NAC(s), and/or IP-*CTRL devices, as indicated on construction documents. The contractor shall configure the graphical visualization software in accordance with project requirements.
 - .1 The graphic visualization software (displays) will be the same for both EMCS and Lighting Controls utilizing the same tools, displays and features for both.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .2 The graphical visualization software must provide a workflow oriented “drag & drop” Graphical User Interface (GUI) tool(s), to easily provide endusers with cost and time saving analytical tools including dashboards, playback, alarm consoles, and more.
- .3 The graphical visualization software must deliver dynamic and interactive content such as floor layouts with heat/cool maps, graphics, charts, dynamic equipment views...
- .2 The graphical visualization software shall have two operating modes: Studio & Viewer, as described below. For both Studio & Viewer modes, the graphical user interface shall be delivered to the user by pointing a modern web browser to a project-specific URL and logging into the system. The software shall not require any software plugins to be installed in conjunction with the web browser.
- .3 When delivered to a modern web browser, the software shall implement web development standards, including but not limited to Hypertext Markup Language (HTML) v5, Cascading Style Sheets (CSS) v3, and JavaScript (in compliance with ECMAScript specifications).
- .4 Studio Mode:
 - .1 The graphical visualization software shall allow upload of user-generated content such as logos or floorplan background images in formats including .BMP, .JPG, .PNG, .SVG...
 - .2 The graphical visualization software shall allow assembly and configuration of repeatable design elements, such as a table row for a points list, or an informative callout for equipment on a floor plan.
 - .3 The graphical visualization software shall allow for use of dynamic, zoomable, extensible mapping interfaces, such as Google Maps, provided internet connectivity.
 - .4 The graphical visualization software shall allow the access and integration of information found on the Internet into displays, provided internet connectivity
 - .5 The graphical visualization software shall support creation and configuration of multiple chart types, including but not limited to line charts, bar charts, area charts, pie charts, including use of multiple foreground and background colors, legend positioning and color gradients.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .1 Images and widgets offer pre-built functional, graphics-oriented components, with predefined parameter configurations and offer advanced servicing features with dynamic graphical functions such as:
 - .1 Trends - select and graph data points; and view, compare and analyze historical data, such as energy consumption or system performance
 - .2 Schedules - graphically configure weekly schedules and holidays
 - .3 Callout - view values and status of points (alarm, override, etc.) and take actions
 - .4 Weather – easily display current weather conditions in your graphics for a specified location
 - .5 List - display a points list table by dragging and dropping any points over the widget to populate the table list
 - .6 Layer selection – toggle between different heat map layers and control which layer is currently active (lighting, HVAC, energy, etc.)
 - .7 Date range picker – select a specific date range to display history or chart content, and the Playback widget
 - .8 Charts and gauges – display values for specified data metrics using chart or gauges
- .6 The graphic visualization software shall allow both view and manipulation (subject to user access level) of real-time data present on the host, as well as historical trend data. The scope of data shall depend only on whether the host device is an operator workstation, server, NAC, or IP-*-CTRL device and has been fully configured to meet project-required sequence of operation.
- .7 The graphic visualization software shall allow binding of any data and/or data manipulation method to applicable graphical design elements, including but not limited to: text labels, buttons, charts, geographical mapping interfaces, applied against applicable properties including but not limited to: position/size, background image/color, foreground color, foreground font properties, visibility, opacity, animation timing and rotation.

EMCS: Computer Systems, MMI
SECTION 25 10 02

- .8 The graphic visualization software shall allow manipulation of position/scaling properties of any and all visual elements, with respect to user's screen size, parent and nested visual elements, and/or "User Agent Type" (designating Web Browser vendor and version), such that graphical screens created may be delivered and perform equally well on laptop screens, large displays, and/or mobile devices.
- .5 Viewer Mode:
 - .1 In viewer mode, the graphical visualization software shall deliver content to the user's web browser in a fashion that matches configuration accomplished in Studio Mode.
 - .2 Scope and amount of content delivered in Viewer mode, and access to data manipulation methods shall be determined by which user has authenticated.

END OF SECTION

EMCS: Field Controllers
SECTION 25 30 01

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 35 13, EMCS: Actuators and Operators
- .8 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .9 SECTION 25 35 19, EMCS: Control Valves
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

PART 2 - PRODUCT

2.1 EMCS CONTROLLERS

- .1 Controllers –BACnet/IP Protocol
 - .1 Provide BACnet Controllers that are BACnet Testing Laboratory listed (v12 or later) as specified herein:
 - .1 BACnet Building Controller (B-BC)
 - .2 BACnet Advanced Application Controller (B-AAC)
 - .3 BACnet Application Specific Controller (B-ASC)

EMCS: Field Controllers
SECTION 25 30 01

- .2 All BACnet/IP Controllers shall use the following communication specifications and achieve performance as specified herein:
 - .1 All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (NCU).
 - .1 Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
 - .2 Performance
 - .1 Each BACnet controller shall have a minimum of 512KB of RAM and 4GB of non-volatile flash memory.
 - .2 Each controller shall have a 32-bit microprocessor operating at 600 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
 - .3 BACnet Controllers shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings.
 - .1 The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
 - .4 Control Unit (LCU) and Terminal Control Unit (TCU)
 - .1 Shall be fully programmable and the programming software shall have a library of pre-built, tested, and user re-definable control sequences for a wide range of typical HVAC applications.
 - .2 All control sequences programmed into the LCU and TCU shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 - .3 LCU and TCU controllers that are not fully programmable and/or cannot retain programming as outlined in .2 are not acceptable.
 - .5 BACnet Controllers shall communicate with the Network Control Unit (NCU) via a BACnet/IP connection at a baud rate of not less than 100 Mbps

EMCS: Field Controllers
SECTION 25 30 01

- .6 BACnet TCU to have a communications port for connecting a matching room temperature and/or humidity sensor and does not utilize any of the I/O points of the Controller.
 - .1 The TCU and all other devices on the BACnet bus shall be accessible from this communications port.
 - .7 The Contractor supplying the BACnet Controllers shall provide documentation for each device, with the following information at a minimum:
 - .1 BACnet Device; MAC address, name, type and instance number.
 - .2 BACnet Objects; name, type and instance number
 - .8 Each BACnet controller is supplied with a unique coded label (e.g. QRCode), to be read by a vendor supplied hand held device, which provides tracking information (such as location, address, MAC address, ...) for the controller and also allows for the building of an offline network with the information.
 - .1 Labels must have the information coded directly into the label.
 - .1 Labels that only directly provide pointers to the information are not acceptable.
 - .9 It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each BACnet controller, as required by the Point List located in the POINTS LIST section of this specification.
- .2 Local Control Units (LCU) (Primary Systems such as AHU, MAU, Chiller, Boiler, Water System)
 - .1 The Local Control Units (LCU) shall be 32 bit microprocessor-based.
 - .1 The LCU can have an optional factory installed integral color operator interface (see 25 30 01 **Error! Reference source not found.** for details) that provides real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
 - .1 Alternatively a field mounted display and interface, meeting the specified functionality, shall be supplied for each controller in lieu of this requirement.

EMCS: Field Controllers
SECTION 25 30 01

- .2 Each LCU shall have sufficient memory, to support its own operating system and databases, including:
 - .1 Control processes
 - .2 Energy management applications
 - .3 Alarm management applications
 - .4 Historical/trend data for points specified
 - .5 Maintenance support applications
 - .6 Custom processes
 - .7 Manual override monitoring
- .3 Each LCU shall support:
 - .1 Monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:
 - .1 Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - .2 Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - .3 Each LCU shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:
 - .4 Digital outputs (contact closure for motor starters up to size 4).
 - .5 Analog outputs of 4-20 mA and 0-10 Vdc.
- .4 The LCU analog or universal input shall use a 16 bit A/D converter.
 - .1 Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
- .5 The LCU analog or universal output shall use a 10 bit D/A converter.
- .6 Each LCU shall have a minimum of 10% spare capacity for each point type for future point connection.

EMCS: Field Controllers
SECTION 25 30 01

- .1 Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- .2 As a minimum, provide one of each type of point available on the controller.
- .7 Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
- .8 The LCU's optional factory installed color operator interface will provide real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
 - .1 The operator interface shall consist of :
 - .1 An icon-based, interactive backlit color display.
 - .2 A turn and select navigation jog dial to access, edit, and modify internal controller functions. The jog dial shall be used to navigate through menus, select options and icons, and change parameters. Scroll buttons (up, down, left and right) shall not be acceptable.
 - .3 Navigable menus to display, select, edit, and modify values and other controller information.
 - .4 List-based menus with a minimum of eight (8) lines of text.
 - .5 Icon-based menus.
 - .6 A display with the following minimum characteristics: a resolution of 400 W x 240 H pixels with an effective viewing area of 61.2mm x 36.7 mm H, and 71mm diagonal viewing area.
 - .2 The operator interface shall use color-codes with icons and text lists to indicate values and controller statuses.
 - .3 The operator interface shall, at a minimum, have the following functions:

EMCS: Field Controllers
SECTION 25 30 01

- .1 Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, multistate values, Intelligent Space Sensor (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) inputs, and wireless inputs.
 - .1 The points list menus shall allow the operator to monitor, set, and override controller points and values.
 - .2 A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.
- .2 Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
 - .1 The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
 - .2 The combination of an icon and its color state shall notify the operator of an alarm condition.
 - .3 The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.
- .3 Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
- .4 PID loops. The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).

EMCS: Field Controllers
SECTION 25 30 01

- .5 The operator interface shall support Latin-based languages and allow the interface user to select from three (3) defined languages.
 - .6 The operator interface shall allow personalization of a contact information screen with a minimum of eight (8) lines of user configurable text as well as the option to add a color graphic such as a company logo. The tool shall support, but not be limited to; image file formats such as GIF, PNG, JPG, etc.
 - .7 Favorites. The operator interface shall allow access to a list of bookmarked points.
 - .8 Weather. The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.
 - .9 Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. A password icon shall indicate the lock mode state.
 - .10 Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.
- .9 The LCU shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components.
- .1 The controller shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication.
- .10 Should the LCU memory be lost for any reason, the user shall have the capability of reloading the controller software via the EMCS LAN OWS or Server.
- .1 Controller requiring a local port to reload the controller software is not acceptable.
- .11 Wireless port supporting a wireless transceiver for communication with wireless sensors/switches

EMCS: Field Controllers
SECTION 25 30 01

- .12 Acceptable Products:
 - .1 BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) or BACnet Advanced Application Controller (B-AAC)
- .3 IP Plant Controller (IP-SYS-CTRL)
 - .1 The IP-SYS-CTRL shall be 32 bit microprocessor-based operating at a minimum of 1 GHz.
 - .1 They shall be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.
 - .2 Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
 - .2 Each IP-SYS-CTRL shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases, including:
 - .1 Control processes
 - .2 Energy management applications
 - .3 Alarm management applications
 - .4 Historical/trend data for points specified
 - .5 Maintenance support applications
 - .6 Custom processes
 - .7 Web Based interface via integral Web Server.
 - .8 Support for up to a minimum of 256 I/O points which are added via Expansion I/O modules.
 - .9 Shall have a graphical interface with a common library of HVAC system image and animation such as AHU, MAU, Boiler Plant, Chiller Plant, and Rooftop Unit.
 - .3 The IP-SYS-CTRL shall have a Real Time clock.
 - .4 The IP-SYS-CTRL will support the following communications protocols:
 - .1 BACnet/IP

EMCS: Field Controllers
SECTION 25 30 01

- .1 Supporting IPv4 addressing.
- .2 DHCP support and Auto DNS.
- .3 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - .1 Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
- .4 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
- .2 BACnet MS/TP supporting up to minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
 - .1 Supporting 9600 to 115200 baud
- .3 Modbus RTU
 - .1 Supporting 9600 to 115200 baud
- .4 Modbus TCP
- .5 2 x USB 2.0 Expansion ports for:
 - .1 802.11 Wi-Fi Adapter enabling wireless connectivity including:
 - .1 'Hot Spot'
 - .2 Client
 - .3 Access Point.
 - .2 If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality.
- .5 Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module.
- .6 Acceptable Products:
 - .1 BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.

EMCS: Field Controllers
SECTION 25 30 01

- .4 IP-SYS-CTRL Communication Modules.
 - .1 Each IP-SYS-CTRL Communication module shall be capable of RS-485 communication with the following requirements, without the additional gateways/routers to enable RS-485 communication:
 - .1 Include two separate RS-485 communication ports.
 - .2 Allow for either Modbus RTU or BACnet MS/TP communication on either of the ports.
 - .2 Allow for a minimum of 32 Modbus RTU communicating devices and/or a minimum of 50 BACnet MS/TP communicating devices to be connected on each RS-485 segment. .
- .5 IP-SYS-CTRL Expansion I/O modules:
 - .1 Each IP-SYS-CTRL Expansion I/O module shall be capable of monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:
 - .1 Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - .2 Pulse accumulators at 120Hz resolution.
 - .3 Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - .1 The analog or universal input shall use a 16 bit A/D converter.
 - .2 Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
 - .2 Each IP-SYS-CTRL Expansion I/O module shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:
 - .1 Digital outputs.
 - .1 Optional Form C relay outputs.
 - .2 Optional Triac Outputs.
 - .2 Analog outputs of 4-20 mA and 0-10 Vdc.
 - .1 The analog or universal output shall use a 10 bit D/A converter.

EMCS: Field Controllers
SECTION 25 30 01

- .3 HOA (Hand, Off, Auto) support.
- .3 Each completed configuration of IP-SYS-CTRL and Expansion I/O modules shall have a minimum of 10% spare capacity for each point type for future point connection.
 - .1 Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
 - .2 As a minimum, provide one of each type of point available on the controller.
- .4 Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
- .6 IP nLight ECLYPSE™ System Controller (IP-NE-CTRL)
 - .1 The IP-NE-CTRL shall be 32 bit microprocessor-based operating at a minimum of 1 GHz.
 - .1 They shall be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
 - .2 Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
 - .2 Each IP-NE-CTRL shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases, including:
 - .1 Control processes
 - .2 Alarm management applications
 - .3 Maintenance support applications
 - .4 Custom processes
 - .5 Web Based interface via integral Web Server.
 - .6 Shall have a graphical interface with a common library of nLight system images.
 - .3 The IP-NE-CTRL shall have a Real Time clock.

EMCS: Field Controllers
SECTION 25 30 01

- .4 The IP-NE-CTRL will support the following communications protocols:
 - .1 BACnet/IP
 - .1 Supporting IPv4 addressing.
 - .2 DHCP support and Auto DNS.
 - .3 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - .1 Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
 - .4 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
 - .5 Network Lighting Control (NLC)
 - .6 Supporting up to 1500 NLC devices.
 - .7 3 – RJ45 ports supporting NLC networks.
 - .8 Refer to 26 09 43 for NLC devices.
 - .9 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
 - .2 BACnet MS/TP supporting up to minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
 - .1 Supporting 9600 to 115200 baud
 - .3 2 x USB 2.0 Expansion ports for:
 - .1 802.11 Wi-Fi Adapter enabling wireless connectivity including:
 - .1 'Hot Spot'
 - .2 Client
 - .3 Access Point.
 - .4 Spanning Tree Protocol

EMCS: Field Controllers
SECTION 25 30 01

- .2 If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality.
- .5 Shall contain a "FIPS 140-2 Level 1 Inside" cryptographic module.
- .6 Refer to SECTION 26 09 43 ELECTRICAL Network Lighting Control for additional information and end devices.
- .7 Acceptable Products:
 - .1 BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
- .7 IP Equipment Controller (IP-EQUIP-CTRL).
 - .1 The IP-EQUIP-CTRL shall be 32 bit microprocessor-based operating at a minimum of 600 MHz.
 - .1 They shall be multi-tasking, real-time digital control processor based supporting a fixed I/O point count.
 - .2 Each IP-EQUIP-CTRL shall have minimum of 512MB memory, with a minimum of 4 GB non-volatile flash, to support its own operating system and databases, including:
 - .1 Control processes
 - .2 Maintenance support applications
 - .3 Custom processes
 - .4 Energy management applications
 - .5 Alarm management applications
 - .6 Historical/trend data for points specified
 - .7 Embedded Web Server for local hosting of graphicsThe IP-EQUIP-CTRL shall have a Real Time clock with rechargeable battery.
 - .4 Power Requirements
 - .1 24 VAC with local transformer power
 - .2 The IP-EQUIP-CTRL will support the following communications protocols:
 - .3 BACnet/IP

EMCS: Field Controllers
SECTION 25 30 01

- .1 Supporting IPv4 addressing.
 - .2 DHCP support and Auto DNS.
 - .3 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - .4 Supporting controller daisy-chain topology on the wired IP network via integrated switch functionality.
 - .5 Integrated fail-safe should allow for communication when the controller is powered down.
 - .6 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
- .4 2 x USB 2.0 Expansion ports for:
- .1 802.11 Wi-Fi Adapter enabling wireless connectivity including:
 - .1 'Hot Spot'.
 - .2 Client
 - .3 Access Point.
 - .2 If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality..
- .5 The IP-EQUIP-CTRL controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC ($\pm 15\%$), allowing for power source fluctuations and voltage drops.
- .6 The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.
- .7 The controllers shall also function normally under ambient conditions of -40 °F to 70 °C and 0% to 90% RH (non-condensing).
- .8 Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
- .9 Provide a minimum of 8 software configurable Universal Inputs capable of supporting the following input signal types: .

EMCS: Field Controllers
SECTION 25 30 01

- .1 Analog Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
- .2 Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - .1 The analog or universal input shall use a 16 bit A/D converter.
- .3 Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
- .10 Provide a minimum of 2 software configurable Universal Outputs capable of supporting the following output signal types:
 - .1 Digital outputs.
 - .2 Analog outputs of 4-20 mA and 0-10 Vdc.
 - .1 The analog or universal output shall use a 10 bit D/A converter.
- .11 Provide a minimum of 4 digital/Triac outputs. .
- .12 Provide a minimum of 2 software configurable outputs that can either be utilized as additional digital/Triac outputs or as universal outputs. .
- .13 Provide a minimum of 3 Modbus connected devices. .
 - .1 Provide (optional) on-board RS-485 communication for Modbus RTU communication to a minimum of 3 connected devices on the RS-485 segment. .
 - .2 Provide (optional) Modbus TCP communication to a minimum of 3 connected devices.
- .14 Provide connection to Intelligent Space Sensors (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) via on-board RJ-45 subnetwork port.
- .15 Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module.
- .8 IP Terminal Unit Controller (IP-TU-CTRL) .
 - .1 The IP-TU-CTRL shall be 32 bit microprocessor-based operating at a minimum of 600 MHz. .

EMCS: Field Controllers
SECTION 25 30 01

- .1 They shall be multi-tasking, real-time digital control processor based supporting a fixed I/O point count.
- .2 Each IP-TU-CTRL shall have minimum of 512MB memory, with a minimum of 4 GB non-volatile flash, to support its own operating system and databases, including: .
 - .1 Control processes
 - .1 Maintenance support applications
 - .2 Custom processes
 - .3 Energy management applications
 - .4 Alarm management applications
 - .5 Historical/trend data for points specified
 - .6 Embedded Web Server for local hosting of graphics.
- .3 The IP-TU-CTRL shall have a Real Time clock with rechargeable battery.
- .4 Power Requirements.
 - .1 24 VAC with local transformer power.
- .5 The IP-TU-CTRL will support the following communications protocols: .
 - .1 BACnet/IP.
 - .1 Supporting IPv4 addressing.
 - .2 DHCP support and Auto DNS.
 - .3 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - .1 Supporting controller daisy-chain topology on the wired IP network via integrated switch functionality.
 - .2 Integrated fail-safe should allow for communication when the controller is powered down.
 - .3 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.

EMCS: Field Controllers
SECTION 25 30 01

- .2 2 x USB 2.0 Expansion ports for:
 - .1 802.11 Wi-Fi Adapter enabling wireless connectivity including: .
 - .1 'Hot Spot'.
 - .2 Client
 - .3 Access Point.
 - .2 If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality..
- .3 1 x micro-USB 2.0 Expansion port
- .6 The IP-TU-CTRL controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC ($\pm 15\%$), allowing for power source fluctuations and voltage drops.
- .7 The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.
- .8 The controllers shall also function normally under ambient conditions of 5°C to 40 °C and 0% to 90% RH (non-condensing).
- .9 Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
- .10 Provide a minimum of 3 software configurable Universal Inputs capable of supporting the following input signal types:
 - .1 Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - .2 Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - .1 The analog or universal input shall use a 16 bit A/D converter.
 - .2 Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
- .11 Provide a minimum of 1 digital Input capable of supporting the following input signal types:

EMCS: Field Controllers
SECTION 25 30 01

- .1 Digital inputs from dry contact closure.
 - .12 Provide a minimum of 1 relay contact output.:
 - .13 Provide a minimum of 3 unpowered relay outputs.:
 - .14 Provide a minimum of 2 digital/Triac outputs at 24VAC.
 - .15 Provide a minimum of 2 analog outputs.
 - .16 Provide a minimum of 2 software configurable outputs that can either be utilized as additional digital outputs or as analog outp
 - .17 Provide connection to Intelligent Space Sensors (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) via on-board RJ-45 subnetwork port.
 - .18 Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module
- .9 IP Power Terminal Unit Controller (IP-PTU-CTRL) .
- .1 The IP-PTU-CTRL shall be 32 bit microprocessor-based operating at a minimum of 600 MHz. .
 - .1 They shall be multi-tasking, real-time digital control processor based supporting a fixed I/O point count.
 - .2 Each IP-PTU-CTRL shall have minimum of 512MB memory, with a minimum of 4 GB non-volatile flash, to support its own operating system and databases, including: .
 - .1 Control processes
 - .7 Maintenance support applications
 - .8 Custom processes
 - .9 Energy management applications
 - .10 Alarm management applications
 - .11 Historical/trend data for points specified
 - .12 Embedded Web Server for local hosting of graphics.
 - .3 The IP-PTU-CTRL shall have a Real Time clock with rechargeable battery.
 - .4 Power Requirements.

EMCS: Field Controllers
SECTION 25 30 01

- .1 100 – 220 VAC.
- .5 The IP-PTU-CTRL will support the following communications protocols: .
 - .1 BACnet/IP.
 - .1 Supporting IPv4 addressing.
 - .2 DHCP support and Auto DNS.
 - .3 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - .1 Supporting controller daisy-chain topology on the wired IP network via integrated switch functionality.
 - .2 Integrated fail-safe should allow for communication when the controller is powered down.
 - .3 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
 - .2 2 x USB 2.0 Expansion ports for:
 - .1 802.11 Wi-Fi Adapter enabling wireless connectivity including: .
 - .1 'Hot Spot'.
 - .2 Client
 - .3 Access Point.
 - .2 If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality..
 - .3 1 x micro-USB 2.0 Expansion port
- .6 The IP-PTU-CTRL controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC ($\pm 15\%$), allowing for power source fluctuations and voltage drops.
- .7 The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.

EMCS: Field Controllers
SECTION 25 30 01

- .8 The controllers shall also function normally under ambient conditions of 5°C to 40 °C and 0% to 90% RH (non-condensing).
- .9 Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
- .10 Provide a minimum of 3 software configurable Universal Inputs capable of supporting the following input signal types:
 - .1 Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - .2 Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - .1 The analog or universal input shall use a 16 bit A/D converter.
 - .2 Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
- .11 Provide a minimum of 1 digital Input capable of supporting the following input signal types:
 - .1 Digital inputs from dry contact closure.
- .12 Provide a minimum of 1 relay contact output.:
- .13 Provide a minimum of 3 unpowered relay outputs.:
- .14 Provide a minimum of 2 digital/Triac outputs at 24VAC.
- .15 Provide a minimum of 2 analog outputs.
- .16 Provide a minimum of 2 software configurable outputs that can either be utilized as additional digital outputs or as analog outp
- .17 Provide connection to Intelligent Space Sensors (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) via on-board RJ-45 subnetwork port.
- .18 Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module
- .10 IP VAV Controller (IP-VAV)
 - .1 Refer to 25 30 01 Variable Air Volume (VAV) Terminal Control Units (TCU) for VAV related functionality requirements.

EMCS: Field Controllers
SECTION 25 30 01

- .1 In cases of conflict between this section (IP-VAV) and the referenced section (VAV) this section (IP-VAV) takes precedence.
- .2 The IP-VAV-CTRL shall be 32 bit microprocessor-based operating at a minimum of 400 MHz.
- .3 They shall be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.
- .4 Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- .5 Each IP-VAV-CTRL shall have minimum of 512MB memory, with a minimum of 1GB non-volatile flash, to support its own operating system and databases, including:
 - .1 Control processes
 - .2 Maintenance support applications
 - .3 Custom processes
- .6 The IP-VAV-CTRL shall have a Real Time clock with rechargeable battery.
- .7 Power Requirements
 - .1 24 VAC with local transformer power
 - .2 50 VAC utilizing Power Over Ethernet (POE)
- .8 The IP-VAV-CTRL will support the following communications protocols:
 - .1 BACnet/IP
 - .1 Supporting IPv4 addressing.
 - .2 DHCP support and Auto DNS.
 - .3 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - .4 If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.

EMCS: Field Controllers
SECTION 25 30 01

- .2 2 x USB 2.0 Expansion ports for:
 - .1 802.11 Wi-Fi Adapter enabling wireless connectivity including:
 - .1 'Hot Spot'
 - .2 Client
 - .3 Access Point
 - .2 If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality.
- .9 Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module
- .10 Acceptable Products:
 - .1 BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC)
- .11 Variable Air Volume (VAV) Terminal Control Units (TCU)
 - .1 The VAV TCU controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC ($\pm 15\%$), allowing for power source fluctuations and voltage drops.
 - .2 The EMCS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.
 - .3 The controllers shall also function normally under ambient conditions of 0 °C to 50 °C and 5% to 90% RH (non-condensing).
 - .4 Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
 - .5 The VAV TCU shall include a built-in 'flow thru' differential pressure transducer.
 - .1 The controller shall convert this value to actual air flow.
 - .2 Single point differential pressure sensing device is not acceptable.
 - .3 Membrane based pressure differential transducer is not acceptable.

EMCS: Field Controllers
SECTION 25 30 01

- .4 The VAV TCU differential pressure transducer shall have a measurement range of 0 to 500 Pa and measurement accuracy of $\pm 4\%$ at 12.5 to 500 Pa and a minimum resolution of 0.025 Pa, insuring primary air flow conditions shall be controlled and maintained to within $\pm 5\%$ of setpoint at the specified minimum and maximum air flow parameters.
- .5 VAV TCU differential pressure transducer requiring periodic zero value air flow calibration is not acceptable.
- .6 The EMCS contractor shall verify the type of differential pressure sensors used in the existing boxes, and ensure compatibility with the VAV TCU controllers.
- .7 The VAV TCU shall include provision for air flow balancing using a local air flow balancing interface.
- .8 An Intelligent Space Sensor (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) shall be used for balancing air flow.
 - .1 In lieu of an ISS, a portable air flow balancing interface capable of balancing air flow is acceptable.
- .9 The portable air flow balancing interface shall connect to the VAV TCU or the matching room temperature sensor.
- .10 The VAV TCU shall also provide an air flow balancing tool.
- .11 This tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
- .12 Systems not able to provide a web based air balance tool or a portable air flow balancing interface or an Intelligent Space Sensor (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) capable of balancing air flow as part of the VAV TCU controller shall provide an individual full time technician during the air flow balancing process to assure full balance compliance.
- .13 The VAV box controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature to within ± 0.9 °C of setpoint at the room sensor location.

EMCS: Field Controllers
SECTION 25 30 01

- .14 Each controller shall also incorporate an algorithm that allows for resetting of the associated air handling unit discharge temperature if required to satisfy space requirements.
 - .1 This algorithm shall function to signal the respective controller to perform the required discharge temperature reset in order to maintain space temperature setpoint.
- .15 It shall be possible to view and reset the space temperature, temperature setpoint, maximum airflow setting, minimum airflow setting, and actual airflow, through the EMCS LAN.

2.2 LOCAL DISPLAY UNIT (LDU)

- .1 The LDU must provide for a color operator interface allowing for real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
 - .1 The operator interface shall consist of :
 - .1 An icon-based, interactive backlit color display.
 - .2 A turn and select navigation jog dial to access, edit, and modify internal controller functions. The jog dial shall be used to navigate through menus, select options and icons, and change parameters. Scroll buttons (up, down, left and right) shall not be acceptable.
 - .3 Navigable menus to display, select, edit, and modify values and other controller information.
 - .4 List-based menus with a minimum of eight (8) lines of text.
 - .5 Icon-based menus.
 - .6 A display with the following minimum characteristics: a resolution of 400 W x 240 H pixels with an effective viewing area of 2.4" L x 1.4" H, and 2.8" diagonal viewing area.
 - .2 The operator interface shall use color-codes with icons and text lists to indicate values and controller statuses.
 - .3 The operator interface shall, at a minimum, have the following functions:

EMCS: Field Controllers
SECTION 25 30 01

- .1 Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, multistate values, Intelligent Space Sensor (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) inputs, and wireless inputs.
 - .1 The points list menus shall allow the operator to monitor, set, and override controller points and values.
 - .2 A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.
- .2 Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
 - .1 The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
 - .2 The combination of an icon and its color state shall notify the operator of an alarm condition.
 - .3 The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.
- .3 Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
- .4 PID loops. The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).
- .5 The operator interface shall support Latin-based languages and allow the interface user to select from three (3) defined languages.

**EMCS: Field Controllers
SECTION 25 30 01**

- .6 The operator interface shall allow personalization of a contact information screen with a minimum of eight (8) lines of user configurable text as well as the option to add a color graphic such as a company logo. The tool shall support, but not be limited to; image file formats such as GIF, PNG, JPG, etc.
 - .7 Favorites. The operator interface shall allow access to a list of bookmarked points.
 - .8 Weather. The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.
 - .9 Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. A password icon shall indicate the lock mode state.
 - .10 Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.
- .2 The LDU shall be provided as a din-rail mount or (panel) flush mount as shown on the mechanical drawings.
 - .3 The LDU shall utilize a single cable connection via on-board RJ-45 port, and can be connected to the subnetwork port of any LCU, IP-SYS-CTRL, or IP-EQUIP-CTRL, IP-VAV-CTRL and therefore can be utilized as a hand-held portable operator display.
 - .4 The LDU shall have a minimum rating of IP54 for dusty or splash-prone environments

2.3 IP CONNECTED LOCAL DISPLAY UNIT (IP-LDU)

- .1 The IP Connected Local Display Unit (IP-LDU) shall be provided as a surface mount or flush mount, as noted in construction documents.
- .2 The IP-LDU shall consist of a touch screen display, with included power adapter port and one RJ45 Ethernet port.
- .3 The IP-LDU Connected Local Display Unit shall support connectivity to any single supported field controller accessible on the same IP network.

EMCS: Field Controllers
SECTION 25 30 01

- .4 The IP-LDU shall support user authentication via credential entry. This authentication will determine the user's level of access to the connected field controller.
- .5 The IP-LDU shall support the following functions, without any configuration required, other than IP address configuration and association with a connected field controller:
 - .1 PID Loop Tuning: The IP-LDU shall provide the ability to view PID Loop Performance on a connected field controller in a timestamped, multi-variable chart, and make adjustments to tuning parameters.
 - .2 Trend Viewing: The IP-LDU shall provide the ability to view charts for data points on a connected field controller, such as setpoints or hardware inputs and outputs.
 - .3 Schedule & Calendar Adjustment: The IP-LDU shall provide the ability to view and adjust weekly schedules residing on a connected field controller, as well as calendars (e.g. to make operational exceptions for holidays).
 - .4 Point Data View & Override: The IP-LDU shall provide the ability to view and override data points on a connected field controller, such as setpoints or hardware inputs and outputs.
 - .5 Alarm View & Acknowledgement: The IP-LDU shall provide the ability to view and acknowledge alarms present on the connected field controller.

2.4 MOBILE APPLICATION FOR ANDROID¹ AND iOS² PLATFORMS

- .1 The application for mobile platforms shall provide real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
 - .1 The operator interface consists of :
 - .1 An icon-based, interactive application for Android and iOS devices.
 - .2 Standard Android and iOS navigation methods shall be used to access, edit, and modify internal controller functions and shall be used to navigate through menus, select options and icons, and change parameters.

¹ An open source operating system by Google, based on the Linux kernel.

² A mobile operating system developed by, and a registered mark of, Apple Inc.

EMCS: Field Controllers
SECTION 25 30 01

- .3 Navigable menus to display, select, edit, and modify values and other controller information.
- .4 List-based menus.
- .5 Icon-based menus.
- .2 The operator interface shall use color-codes with icons and text lists to indicate values and controller statuses.
- .3 The operator interface shall, at a minimum, have the following functions:
 - .1 Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, multistate values, Intelligent Space Sensor (ISS) (see section 25 30 01 **Error! Reference source not found. Error! Reference source not found.**) inputs, and wireless inputs.
 - .1 The points lists menus shall allow the operator to monitor, set, and override controller points and values.
 - .2 A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.
 - .2 Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
 - .1 The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
 - .2 The combination of an icon and its color state shall notify the operator of an alarm condition.
 - .3 The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.

EMCS: Field Controllers
SECTION 25 30 01

- .3 Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
- .4 PID loops. The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).
- .5 The operator interface shall support Latin-based languages and allow the interface user to select from three (3) defined languages.
- .6 The operator interface shall allow personalization of a contact information screen with a minimum of eight (8) lines of user configurable text as well as the option to add a color graphic such as a company logo. The tool shall support, but not be limited to; image file formats such as GIF, PNG, JPG, etc.
- .7 Favorites. The operator interface shall allow access to a list of bookmarked points.
- .8 Weather. The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.
- .9 Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. A password icon shall indicate the lock mode state.
- .10 Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.
- .11 Resolution: ± 0.1 °C

**2.5 BLE-ENABLED INTELLIGENT ROOM INTERFACE (BEIRI) (ALLURE
UNITOUCH)**

EMCS: Field Controllers
SECTION 25 30 01

- .1 The BLE-Enabled Intelligent Room Interface (BEIRI) shall communicate with any ECLYPSE Connected Controller and shall provide precise environmental zone control for temperature, fan speed, lighting, and blinds.
- .2
 - .1 Wired communications
 - .1 Type – RS-485
 - .2 Rate – 38,400 bps
 - .3 Cable and Connections
 - .1 Type T568B Cat 5e network cable (4 twisted pairs)
 - .2 Maximum length: 100m
 - .3 Connections
 - .1 IN – RJ-45
 - .2 OUT – RJ-45 for daisy chaining to other room devices)
 - .2 Wireless Communications
 - .1 Type: Bluetooth 4.2
 - .2 Frequency: 2402 – 2480 MHz
- .3 Each BEIRI shall provide a full color Liquid Crystal Display (LCD), where indicated on the drawings, with the following minimum features:
 - .1 Minimum 48.96mm x 73.44mm effective viewing area
 - .2 Backlit
- .4 The BEIRI shall be capable of displaying on its LCD the measured space temperature from 0 °C to 50 °C and/or humidity from 0 % RH to 100 % RH with one decimal and/or the CO2 measurement from 0 to 2000 ppm.
- .5 The BEIRI shall also be capable of displaying the following elements:
 - .1 Space temperature
 - .2 Cooling space temperature set point
 - .3 Heating space temperature set point

EMCS: Field Controllers
SECTION 25 30 01

- .4 Current heating or cooling mode
- .5 Current occupancy mode
- .6 Fan speed
- .7 Light status
- .8 Blind position
- .9 Alarm condition
- .10 Current time
- .11 Energy consumption indicator
- .6 Each BEIRI shall provide a local keypad for local user interface to perform navigation and adjustment of points configured as adjustable.
- .7 Each BEIRI can be controlled, via Bluetooth low energy technology, using a mobile app on a smartphone.
 - .1 Allows for a mirrored user interface which provides remote control from anywhere within range.
- .8 The BEIRI shall be configured for the intended application requirements.
- .9 Provide an BEIRI where indicated on the drawings. Each BEIRI shall provide at a minimum the following on-board integral I/O without the consumption of any inputs and/or outputs at the host controller:
 - .1 Temperature Sensor
 - .1 Sensing Element: 10k Thermistor
 - .2 Accuracy: ± 0.3 °C
 - .3 Resolution: ± 0.1 °C
 - .4 Range: 0 °C to 50 °C
 - .2 Relative Humidity Sensor
 - .1 Accuracy: ± 3 % RH : 0% to 70%
 - .2 Resolution: 1 % RH
 - .3 Range: 10 % RH to 90 % RH
 - .3 CO2 Sensor

EMCS: Field Controllers
SECTION 25 30 01

- .1 Accuracy: 400 to 1,250 ppm $\pm$ 30 ppm or 3% of reading, whichever is greater
1,250 - 2,000 ppm $\pm$ 5% of reading + 30 ppm
 - .2 Range: 0 to 2,000 ppm
 - .3 Calibration method: self-calibration method eliminates the need for manual calibration and calibrates the sensor based on baseline concentrations measured during unoccupied periods in the space. Sensor shall not require manual calibration over a minimum product rated life of 15 years.
 - .4 Temperature dependence: 0.2% FS per °C
 - .5 Stability: <2% of FS over life of sensor (15 years)
 - .6 Pressure dependence: 0.135% of reading per mm Hg
 - .7 Sensing method: Non-dispersive infrared (NDIR) absorption and Gold plated optics.
- .10 The BEIRI shall provide password protected menus or any other mechanism to prevent a local user to access advanced configuration menus
- .11 The BEIRI shall be capable of promoting good energy usage practices to the room occupant by displaying an Energy Consumption Indicator (ECI).
- .1 The ECI shall be modified in real-time when the room occupant modifies a parameter such as the room temperature setpoint or the fan speed.
 - .2 The ECI shall indicate to the room occupant the energy impact of the parameter changes via a 5 level display icon where a full display (5th level) indicates excellent energy conservation and no display indicating no energy conservation.
 - .3 The ECI follows the algorithm for energy efficiency as outlined in ASHRAE 55-2004.
 - .4 If ECI is not available then:
 - .1 A stainless steel plate with 4 LEDs must be mounted adjacent to the thermostat.
 - .2 The plate is to be engraved, adjacent to each LED, with symbology which will encourage the occupant to conserve energy.

EMCS: Field Controllers
SECTION 25 30 01

- .3 ECI level (0 to 4) is to be indicated via digital outputs driving the LEDs.
 - .4 Algorithm to be used; as defined in ASHRAE 55-2004
- .12 Standards and Regulations
 - .1 The BEIRI must meet or exceed the following:
 - .1 CE
 - .1 Emission EN 61000-6-3: 2007 + A1: ed.2011; Generic standards for residential, commercial and light-industrial environments
 - .2 Immunity EN 61000-6-1: 2007; Generic standards for residential, commercial and light-industrial environments
 - .2 FCC
 - .1 Complies with FCC rules part 15, subpart B class B
 - .3 UL Listed (CDN & US)
 - .1 UL916 Energy management equipment
 - .4 WEEE
 - .1 Marked according to the Waste Electrical and Electronic Equipment (WEEE) directive.
 - .5 RoHS
 - .1 All materials and manufacturing processes must comply with the RoHS directive.

2.6 BLE-ENABLED MULTI SENSOR (BEMS)

- .1 The BLE-Enabled Multi-Sensor (BEMS) shall communicate with any controller and shall provide precise environmental zone values for luminosity, motionsensing, and temperature as well as Bluetooth low energy connectivity
- .2 BEMS
 - .1 Wired communications
 - .1 Type – RS-485
 - .2 Rate – 38,400 bps

EMCS: Field Controllers
SECTION 25 30 01

- .3 Cable and Connections
 - .1 Type T568B Cat 5e network cable (4 twisted pairs)
 - .2 Maximum length: 100m
 - .3 Connections
 - .1 IN – RJ-45
- .2 Wireless Communications
 - .1 Type: Bluetooth 4.2
 - .2 Frequency: 2402 – 2480 MHz
- .3 Each BEMS can be accessed, via Bluetooth low energy technology, using a mobile app on a smartphone.
 - .1 Allows for a mirrored user interface which provides remote control from anywhere within range.
- .4 The BEMS shall have an integrated LED indicator to:
 - .1 Facilitate the localization and commissioning of the sensor.
 - .2 Provide a pairing indicator when mobile application is used.
- .5 The BEMS shall be configured for the intended application requirements.
- .6 Provide a BEMS where indicated on the drawings. Each BEMS shall provide at a minimum the following on-board integral I/O without the consumption of any inputs and/or outputs at the host controller:
 - .1 Temperature Sensor
 - .1 Sensing Element: 10k NTC Thermistor
 - .2 Range: 5 °C to 40 °C
 - .2 Luminosity Sensor
 - .1 Type: Photodiode
 - .2 Response Type: Human eye
 - .3 Range: 0-4000 lux
 - .3 Motion Sensor
 - .1 Optic: 16 face Fresnel lens

EMCS: Field Controllers
SECTION 25 30 01

- .2 Type: Ouad type passive infrared element
- .3 Rated detection distance: 5m
- .4 Minimum temperature difference between target and surroundings 4°C
- .5 Detection Range
 - .1 Length: 94°
 - .2 Width: 82°
 - .3 Detection zones: 64
- .7 Standards and Regulations
 - .1 The BEMS must meet or exceed the following:
 - .1 CE
 - .1 Emission EN 61000-6-3: 2007 + A1: ed.2011; Generic standards for residential, commercial and light-industrial environments
 - .2 Immunity EN 61000-6-1: 2007; Generic standards for residential, commercial and light-industrial environments
 - FCC
 - .1 FCC rules part 15, subpart B class B
 - .3 UL Listed (CDN & US)
 - .1 UL916 Energy management equipment
 - .4 WEEE
 - .1 Marked according to the Waste Electrical and Electronic Equipment (WEEE) directive.
 - .5 RoHS
 - .1 All materials and manufacturing processes must comply with the RoHS directive.

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATION

EMCS: Field Controllers
SECTION 25 30 01

- .1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 GENERAL WORKMANSHIP

- .1 Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- .3 Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- .4 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- .5 Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.3 FIELD QUALITY CONTROL

- .1 Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.
- .2 Continually monitor field installation for code compliance and workmanship quality.
- .3 Contractor shall arrange for work inspection by authorities having jurisdiction over the work.

3.4 WIRING

- .1 Control and interlock wiring and installation shall comply with national and local electrical codes, Division 16, and manufacturer's recommendations. Where the requirements of this Section differ from other Divisions, this Section shall take precedence.
- .2 NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC
- .3 Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
- .4 NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.

EMCS: Field Controllers
SECTION 25 30 01

- .5 Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
- .6 Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
- .7 Do not install wiring in raceway containing tubing.
- .8 Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m intervals
- .9 Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- .10 Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
- .11 Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
- .12 Include one pull string in each raceway 2.5 cm or larger.
- .13 Use color-coded conductors throughout.
- .14 Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- .15 Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm between raceway and high-temperature equipment such as steam pipes or flues.
- .16 Adhere to requirements in Division 16 where raceway crosses building expansion joints.
- .17 Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
- .18 Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

EMCS: Field Controllers
SECTION 25 30 01

- .19 Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
- .20 Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.5 COMMUNICATION WIRING

- .1 Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
- .2 Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
- .3 During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- .4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .5 Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- .6 Each run of communication wiring shall be a continuous length without splices when that length is commercially available.
 - .1 Runs that are longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- .7 Label communication wiring to indicate origination and destination.
- .8 Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.6 FIBER OPTIC CABLE

- .1 Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

EMCS: Field Controllers
SECTION 25 30 01

- .2 Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.
- .3 During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- .4 Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

END OF SECTION

EMCS Actuators and Operators
SECTION 25 35 13

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .9 SECTION 25 35 19, EMCS: Control Valves
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

PART 2 - PRODUCT

2.1 ACTUATORS

- .1 For dampers, the actuators used shall be provided from a single manufacturer
- .2 For valves, the actuators used shall be provided from a single manufacturer
- .3 Actuators shall be provided from a manufacturer registered under ISO9001:2000.
- .4 Electronic Damper Actuators.

EMCS Actuators and Operators
SECTION 25 35 13

- .1 Size for torque required for damper seal at load conditions.
 - .2 Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
 - .3 Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
 - .4 Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
 - .5 Fail-Safe Operation: Mechanical, spring-return mechanism. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.
 - .6 Power Requirements (Two-Position Spring Return): 24 or 120 VAC as required.
 - .7 Power Requirements (Proportional): Maximum 10 VA at 24 VAC or 8 W at 24 VDC.
 - .8 Temperature Rating: -30 to +50°C
 - .9 Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
 - .10 Agency Listing: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.
- .5 Electronic Valve Actuators.
- .1 Size for torque required for valve close off at 150% of total system (head) pressure for 2-way valves; and 100% of pressure differential across the valve or 100% of total system (pump) head differential pressure for 3-way valves.
 - .2 Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
 - .3 Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
 - .4 Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
 - .5 Fail-Safe Operation: Mechanical, spring-return mechanism. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.

EMCS Actuators and Operators

SECTION 25 35 13

- .6 Power Requirements: Maximum 10 VA at 24 VAC or 8 W at 24 VDC.
 - .7 Maximum 1 VA at 24 VAC or 1 W at 24 VDC.
 - .8 Temperature Rating: -30 to +50°C
 - .9 Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
 - .10 Agency Listing: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.
- .6 Terminal Unit Actuators
- .1 Close-off (Differential) Pressure Rating: 200 psi.
 - .2 Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle or an ISO-style direct-coupled mounting pad.
 - .3 Power Requirements: Maximum 1 VA at 24 VAC or 1 W at 24 VDC.
 - .4 Temperature Rating: -30 to +50°C Housing Rating: Minimum UL94-5V(B) flammability
 - .5 Agency Listing: CE, UL 60730-1A/-2-14, CAN/CSA E60730-1, CSA C22.2 No. 24-93, CE according to 89/336/EEC.

PART 3 - EXECUTION

3.1 ACTUATORS

- .1 General. Mount actuators and adapters according to manufacturer's recommendations.
- .2 Electric and Electronic Damper Actuators.
 - .1 Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation.
 - .2 Link actuators according to manufacturer's recommendations.
 - .3 For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
 - .4 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately the 5° open position, manually close the damper, and then tighten linkage.

EMCS Actuators and Operators
SECTION 25 35 13

- .5 Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - .6 Provide necessary mounting hardware and linkages for actuator installation.
- .3 Valve Actuators.
- .1 Connect actuators to valves with adapters approved by actuator manufacturer.

END OF SECTION

EMCS Sensors and Transmitters
SECTION 25 35 16

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 19, EMCS: Control Valves
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 Definitions

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

PART 2 - PRODUCT

2.1 SENSORS AND DEVICES

- .1 Input/output sensors and devices shall be closely matched to the requirements of the EMCS controller for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.
- .2 Sensors and transmitters shall be manually calibrated on site so that the wiring length does not detract from the sensor accuracy specified.
- .3 Provide guards (plastic or wire) for sensors, thermostats, and transmitters that are installed in public areas such as gymnasiums, classrooms, corridors, and vestibules.

EMCS Sensors and Transmitters
SECTION 25 35 16

- .4 Temperature sensors shall have the following characteristics:
 - .1 Sensors shall have +/- 0.55 °C accuracy between 0 °C and 100 °C. Space temperature sensors
 - .1 Shall consist of an element within a ventilated cover.
 - .2 Space sensors located in mechanical rooms and public shall contain a network jack, but shall have no ability to adjust temperature setpoint (Set Point Adjustment).
 - .3 Space sensors shall be provided in accordance with the drawings and specifications with the following options:
 - .1 Sensor complete with Network Jack
 - .2 Sensor complete with Network Jack, and Set Point Adjustment
 - .3 Sensor complete with Network Jack, and illuminated Override switch
 - .4 Sensor complete with Network Jack, Set Point Adjustment, and illuminated Override switch
 - .5 Sensor complete with Network Jack, Set Point Adjustment, illuminated Override switch and Fan Speed Selection.
- .5 RTD Transmitter
 - .1 Where reference is made on the drawings for a RTD transmitter, it shall be interpreted as follows:
 - .2 Transmitters shall meet at minimum the following requirements.
 - .1 Provide an RTD transmitter in configurations below meeting the following requirements:
 - .1 100 ohm or 1000 ohm PT RTD
 - .2 24V ac/dc power supply.
 - .3 4-20 mA, 0-10Vdc or 0-5Vdc outputs compatible with BMS.
 - .4 Electronics accuracy of +/-0.1% of span.
 - .5 Operating temperature range of 0°C to 70°C. OSA only - operating temperature range of -40°C to 85°C.

EMCS Sensors and Transmitters
SECTION 25 35 16

- .6 Optional LCD display
- .6 Temperature Sensor – Outside Air
 - .1 Provide outside air temperature sensors as indicated within the field termination schedules and/or controls diagrams.
 - .2 Temperature sensors shall meet, at minimum, the following requirements:
 - .1 Aluminum LB with PVC sun and windscreen.
 - .2 Wall mount weatherproof enclosure with conduit entrance.
 - .3 Thermistor or RTD compatible with BMS
- .7 Temperature Sensor – Duct Mounted – Single Point
 - .1 Provide duct mounted, single point, temperature sensor as indicated within the field termination schedules and/or controls diagrams as follows:
 - .1 In ducts less than 1 m² in cross-sectional area.
 - .2 In ducts greater than 1 m² in cross-sectional area if there is no heating coil and no cooling coil and no mixing of air flows of different temperature upstream.
 - .2 Temperature sensors shall meet, at minimum, the following requirements:
 - .1 6.35 mm stainless steel probe of length between one-third and two-thirds of the duct width.
 - .2 Thermistor or RTD compatible with BMS, sealed in probe with 3 part moisture protection system.
 - .3 Duct mounted ABS plenum rated housing with conduit entrance. (Optional metal, weather proof or no enclosure available)
- .8 Temperature Sensor – Duct Mounted – Averaging
 - .1 Provide duct mounted, averaging, temperature sensor as indicated within the field termination schedules and/or controls diagrams as follows;
 - .1 In ducts greater than 1m² in cross-sectional area.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .2 Temperature sensors shall meet, at minimum, the following requirements:
 - .1 Probe length of 3.66m minimum or 3.25m per m² of duct cross-sectional area, whichever is greater.
 - .2 Copper sheathed or plenum rated flexible construction.
 - .3 Thermistor or RTD compatible with BMS.
 - .4 BMS shall report the monitored temperature with an accuracy of 1.0°C.
 - .5 Duct mounted ABS plenum rated housing with conduit entrance. (Optional metal or weather proof available)
 - .6 Suitable supports at all bends and at intermediate points to prevent movement in the air systems.
- .9 Temperature Sensor – Wall Mounted – Lobby, Hallways Or Security Spaces
 - .1 Provide wall mounted stainless plate temperature sensors for lobbies and lobby vestibule spaces as indicated within the field termination schedules and/or control diagrams as follows.
 - .2 Temperature sensors shall meet, at minimum, the following requirements:
 - .1 Stainless plate sensors to fit 100 x 50mm junction box, available with or without tamperproof screws.
 - .2 Thermistor or RTD compatible with BMS.
- .10 Temperature Sensor – Immersion – Thermo Well Mounted
 - .1 Provide thermo well mounted temperature sensors as indicated within the Field termination schedules and/or control diagrams as follows.
 - .2 Temperature sensors shall meet, at minimum, the following requirements:
 - .1 Rigid 6.35mm stainless steel probe of length, which is, at minimum, 20% of the pipe width.
 - .2 Thermistor or RTD Compatible with BMS sealed in probe with three-part moisture protection system.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .3 BMS shall report the monitored temperature with an accuracy of 0.5°C.
- .4 ABS housing with conduit entrance. (Optional metal or weather proof available)
- .5 Provide Brass or Stainless steel thermo well (316 or 304).
- .6 Provide with thermal grease to aid temperature sensing.

.11 Temperature Sensor – Strap-On

- .1 Provide strap-on mounted temperature sensors as indicated within the Field termination schedules and/or control diagrams or where thermo well mounted sensors cannot be mounted. Temperature sensors shall meet, at minimum, the following requirements:
 - .1 6.35mm Stainless steel probe, 50 mm
 - .2 Thermistor or RTD compatible with BMS, sealed in probe with a three part moisture protection system
 - .3 ABS housing with conduit entrance. (Optional metal or weather proof available)

.12 Temperature Sensor – Strap-On - Plate

- .1 Provide strap-on mounted temperature sensors as indicated within the Field termination schedules and/or control diagrams or where thermo well mounted sensors cannot be mounted. Temperature sensors shall meet, at minimum, the following requirements:
 - .1 Thermistor or RTD compatible with BMS, sealed in probe with a three part moisture protection system
 - .2 A single point strap-on temperature sensor to be precision bonded to a 38mm x 38mm aluminum plate and adhered to 38mm x 25mm compressible foam. A 250mm S/S Pipe clamp to be provided to secure the assembly to various sizes of pipe.
 - .3 ABS housing with conduit entrance. (Optional metal or weather proof available)

.13 Relative Humidity Sensor – Wall Mounted

- .1 Provide wall mounted relative humidity sensors as indicated within the Field termination schedules and/or control diagrams. Humidity sensors shall meet, at minimum, the following requirements:

EMCS Sensors and Transmitters

SECTION 25 35 16

- .1 White protective enclosure
 - .2 Sensor to be laser trimmed thermoset polymer based capacitive type.
 - .3 24 Vac/dc power supply
 - .4 4-20 mA two wire, 0-10 Vdc and 0-5 Vdc output proportional to relative humidity range of 0% to 100% and compatible with BMS.
 - .5 2% accurate (5-95% RH). (3 & 5 % accurate units available)
 - .6 Operating temperature range of 0°C to 70°C.
 - .7 Reverse voltage protected and output limited.
 - .8 Optional LCD display
 - .9 Optional set point adjustment
 - .10 Optional push button override
- .14 Relative Humidity Sensor – Duct Mounted
- .1 Provide duct mounted relative humidity (RH) sensors as indicated within the Field termination schedules and/or control diagrams. Duct mounted relative humidity sensors shall meet, at minimum, the following requirements:
 - .1 ABS housing with conduit entrance.
 - .2 Sensor to be laser trimmed thermoset polymer based capacitive type.
 - .3 24 Vac/dc power supply.
 - .4 4-20 mA two wires, 0-10 Vdc and/or 0-5 Vdc output proportional to relative humidity range of 0% to 100% and compatible with BMS.
 - .5 2% accurate (5-95% RH). (3 & 5 % accurate units available)
 - .6 230mm (9") probe length.
 - .7 Operating temperature range of 0°C to 70°C.
 - .8 Reverse voltage protected and output limited.
 - .9 60 micron HDPE filter

.15 Relative Humidity Sensor – Outside Air

EMCS Sensors and Transmitters

SECTION 25 35 16

- .1 Provide OSA relative humidity (RH) sensors as indicated within the Field termination schedules and/or control diagrams. Humidity sensors shall meet, at minimum, the following requirements:
 - .1 ABS hinged weatherproof housing with conduit entrance.
 - .2 Sensor to be laser trimmed thermoset polymer based capacitive type.
 - .3 24 Vac/dc power supply
 - .4 4-20 mA two wire, 0-10 Vdc and 0-5 Vdc output proportional to relative humidity range of 0% to 100% and compatible with BMS.
 - .5 2% accurate (5-95% RH).
 - .6 Operating temperature range of 0°C to 85°C.
 - .7 Reverse voltage protected and output limited.
- .16 Combination Relative Humidity And Temperature Sensors
 - .1 Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, the BMS Contractor shall provide a combination relative humidity sensor and temperature sensor. The individual sensors must each meet the specifications details above.
- .17 Static Pressure Sensor – Duct Mounted
 - .1 Provide duct mounted static pressure sensors as indicated within the Field termination schedules and/or control diagrams. Static pressure sensors shall meet, at minimum, the following requirements:
 - .1 Input range shall be appropriate for the application. Select range such that it covers from zero duct static pressure relative to the exterior of the duct up to a static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered in the duct relative to the duct exterior. Typically, for low pressure commercial duct consider using a range of 0 to 500Pa, for medium pressure duct use a range of 0 to 1500Pa and for high-pressure duct use a range of 0 to 2500 Pa.
 - .2 4-20mA, 0-5 or 0-10Vdc output proportional to pressure input range compatible with BMS system.

EMCS Sensors and Transmitters
SECTION 25 35 16

- .3 1% Full scale output accuracy
 - .4 Operating temperature range of 0°C to 60°C.
 - .5 Easily accessible, integral non-interacting zero adjustment.
 - .6 Minimum over pressure input protection of two times rated input or 140 kPa whichever is greater.
- .18 Remote Room Condition Monitoring is to be monitored by a Setra Systems, Inc. - MRMS:
- .1 The MRMS (Multiple Room Monitoring Station) monitor shall be capable of monitoring the condition of up to 8 rooms remotely. Each monitor shall communicate via BACnet to a system controller
 - .2 Each monitor shall have a 4.3" TFT, dimmable, full color touch-screen display with a 480 x 272 resolution. The touch screen shall display the current differential pressure, two user defined parameters and the room status (green – ok, red – in alarm, yellow - warning) of each of the monitored rooms
 - .3 Each monitor shall be flush mount design and installed in a standard off-the-shelf electrical wall box with no visible external fasteners; visible screw heads are not acceptable. The Monitor shall be rated for wipe down cleaning procedures.
 - .4 Each Monitor shall have two levels of password protection; user and supervisory. Room type and alarm set points must only be able to be changed using the supervisory security level. Key switches are not acceptable.
 - .5 Each Monitor shall have the ability to be auto-discover other Setra monitors (SRPM/SRCM) on the BACnet network. Each unit shall have the ability to configure which rooms are monitored via the touch screen configuration.
 - .6 The unit should display "Room ID" for each monitored space with the ability to be customized on the monitored unit.
 - .7 Each monitor must have the ability to communicate through the BACnet protocol as installed.
- .19 Differential Room Pressure is to be monitored by a Setra Systems, Inc. - SRCM:

EMCS Sensors and Transmitters

SECTION 25 35 16

- .1 The SRCM room pressure monitor shall be capable of monitoring the differential pressure between two or three individual spaces at all specified locations on the drawings. Each monitor shall have an internal differential pressure sensor with the ability to send an analog output of 4 to 20 mA, 0 to 5 VDC, or 0 to 10 VDC to a system controller, as well as the option to bring in a secondary differential pressure sensor through an analog input on the device. The device shall have a display resolution of 0.0001" WC.
- .2 Each monitor shall have a 4.3" TFT, dimmable, full color touch-screen display with a 480 x 272 resolution. The touch screen shall display the current differential pressure, the room status (green – ok, red – in alarm, yellow - warning) as well integral "Room Condition Banner" in one device. If unit has separate Room Condition Display it will not be considered an equal.
- .3 Monitors must utilize a direct pressure sensing device for differential pressure measurement; flows through technologies (i.e. hot wire anemometers) are not acceptable. The monitor will have an internal pressure sensor as well as the capability to use an external (remote) pressure sensor input. Each monitor must be provided with a NIST traceable calibration certificate for the internal differential pressure transducer
- .4 Each monitor shall be flush mount design and installed in a standard off-the-shelf electrical wall box with no visible external fasteners; visible screw heads are not acceptable. The Monitor shall be rated for wipe down cleaning procedures.
- .5 Each Monitor shall have two levels of password protection; user and supervisory. Room type and alarm set points must only be able to be changed using the supervisory security level. Each monitor shall have 1 touch room status to "Occupied" or "Unoccupied" under the user security level. Key switches are not acceptable.
- .6 Each Monitor shall have the ability to be set in Negative, Positive, or Neutral status enabled through the touch screen. These setting must be able to be stored in memory to speed up room changeover. Key switches are not acceptable.
- .7 The display should have customizable text for "Room ID" and "Room Condition" panels to allow for unique site nomenclature.
- .8 Each Monitor shall be able to be calibrated through the touch screen interface with the touch of a button.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .9 Each Monitor shall have the ability for the setup to be cloned so that the settings can be copied and uploaded to each Room Pressure Monitor in the facility if desired. This is to be done through a standard USB connection.
- .10 Each monitor must have the ability to communicate through the BACnet protocol as installed or have the ability to be field upgradable to BACnet without being sent back to the manufacturer.
- .20 Differential Pressure Sensor – Air (Filter/Coil Monitoring)
 - .1 Provide air differential pressure sensors as indicated in field termination schedules and/or control diagrams. Air differential pressure sensor shall meet, at minimum, the following requirements:
 - .1 Sensors used for filter or coil differential pressures shall also have a display of the monitored differential pressure.
 - .2 Output shall be 4-20mA, 0-10Vdc or 0-5Vdc output proportional to pressure input range compatible with BMS.
 - .3 Select range as required, taking into consideration pressure drop across filter or coil. Typically 0 to 500pa range for low-pressure commercial duct.
 - .4 Operating temperature range of 0°C to 60°C.
- .21 Differential Pressure Switch – Air
 - .1 Provide air differential pressure switches as indicated in field termination schedules and/or control diagrams. Air differential pressure switches shall meet, at minimum, the following requirements:
 - .1 An IP54 (NEMA 13) polycarbonate housing.
 - .2 SPDT switch rated at 250 Vac at 1 amp.
 - .3 Field adjustable range from 50pa to max range of device. Select range as required, taking into consideration pressure drop across filter or coil. Typically 0 to 500pa range for low-pressure commercial duct.
 - .4 Temperature range of –20°C to 60°C.
 - .5 Set point adjustment knob with indication.
 - .6 Automatic reset.

EMCS Sensors and Transmitters
SECTION 25 35 16

.22 Air Flow Sensor

- .1 Provide airflow rate sensors and transducers as indicated in the Field termination schedules and/or control diagrams. Air flow rate sensors and transducer shall meet, at minimum, the following requirements:
 - .1 Hot wire anemometer type.
 - .2 Self-compensation for changes in air temperature.
 - .3 Probe and transducer housing shall be constructed of durable PVC.
 - .4 Probe shall be adjustable from 50-185mm.
 - .5 Power supply shall be 24 Vac/dc.
 - .6 Output signal of 4-20 mA or 0-10Vdc proportional to air flow speed equal to 0-16m/s or 0-8 m/s jumper selectable.
 - .7 Air temperature range of -10°C to 60°C.
 - .8 5% accuracy of measured value.

.23 Water Pressure Sensor

- .1 Provide water pressure sensors as indicated within the Field termination schedules and/or control diagrams. Pressure sensors shall meet the following requirements:
 - .1 Operating range shall be suitable for the application. Select range such that it covers from zero pressure to twice the amount of pressure desired for control purposes or that could be encountered.
 - .2 4-20 mA output proportional to water pressure.
 - .3 0.25% accuracy of range.
 - .4 Temperature range of -40°C to 127°C.
 - .5 Over pressure input protection of a minimum two times rated input.
 - .6 An optional ABS wiring housing is available for an interior application and weatherproof wiring housing is available for an exterior application.
 - .7 17-4PH stainless steel wetted parts.

EMCS Sensors and Transmitters
SECTION 25 35 16

- .8 Burst pressure of a minimum five times rated input.

.24 Water Differential/Gage Pressure Sensor

- .1 Provide water differential or gage pressure sensors as indicated in the Field termination schedules and /or control diagrams. Water differential pressure sensors shall meet, at minimum, the following requirements:
 - .1 Output of 4-20 mA, 0-10 or 0-5 Vdc proportional to the pressure sensed.
 - .2 Momentary over pressure protection of five times the rated input.
 - .3 Operating range shall be suitable for the application. Select range such that it covers from zero differential pressure up to a differential static pressure of 20% to 50% in excess of the maximum static pressure that could be encountered. Remember that if the sensor is used for the control of a chilled water bypass and is located across, for example, a chilled water AHU coil, the pressure drop of both the coil and the associated valve at full design flow have to be taken into account.
 - .4 Accuracy of better than 1% of full-scale reading.
 - .5 Valve tapping shall be furnished and installed by the Mechanical contractor. Coordinate with the Mechanical contractor.

.25 Current Relay/Switch

- .1 Provide current sensing relays as indicated in the Field termination schedules and/or control diagrams. Current sensing relays shall meet, at minimum, the following specifications:
 - .1 Rated for the applicable load.
 - .2 The output relay shall have an accessible trip adjustment over its complete operating range. Provide LED indication of relay status.
 - .3 Current relay shall have input and output isolation via current transformer.
 - .4 Current relay shall be self-powered with no insertion loss.
 - .5 Relay shall be in a dustproof housing.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .6 Accuracy to be <2% of full-scale max.
- .7 Temperature rating of –15°C to 60°C.
- .8 Whenever the status of a single speed motor is monitored it shall be done via a current sensing relay.
- .9 The BMS contractor shall provide current sensing relays at the MCC starters.
- .10 The BMS contractor shall provide the current sensing relays for motors with local starters and no MCC starter.

.26 Current Sensor

- .1 Provide monitoring of the current as identified in Field termination sheets and/or control drawings. Current monitoring shall meet, at minimum, the following requirements:
 - .1 4-20 mA, 0-10 or 0-5 Vdc output proportional to current draw.
 - .2 Reverse polarity protected and output limited.
 - .3 50/60 Hz operation.
 - .4 Accuracy of better than 1%.
 - .5 Operating temperature range of 0°C to 70°C.

.27 Electronic To Pneumatic Transducers

- .1 Provide electronic to pneumatic transducers as identified in the field termination sheets and/or controls drawings. Transducers shall include, at minimum, the following:
 - .1 Accept a control signal of 4-20mA or 0-10Vdc compatible with BMS.
 - .2 Output rating of 21-103 kPa consuming 141 ml/s maximum @ 138 kPa supply.
 - .3 Snap track mounted for panel applications or with an optional ABS enclosure.
 - .4 Operating temperature range of 0°C to 60°C.
 - .5 Male barb fittings for flexible tubing.

.28 Insert-style Impeller Flow Sensor, Liquid, Single-Channel

EMCS Sensors and Transmitters

SECTION 25 35 16

- .1 Impeller flow sensor shall work in conjunction with impeller flow monitor or transmitter to calculate and/or collect readings of the rate of liquid flow and total accumulated flow. Nonmagnetic, spinning impeller is swept forward as liquid passes through the conduit; a low impedance square wave signal is transmitted with a frequency proportional to the flow rate. Sensor shall be suitable for applications in metallic or non-metallic pipes, and plastic versions are suitable for service in corrosive liquids. Power is provided on an analog current loop by receiving device. Impeller assembly is field-replaceable and sensors of similar type are interchangeable. Recalibration after servicing or replacement is not required. All sensor electrical components are self-contained.
- .2 Certifications
 - .1 CE
 - .2 CSA®
- .3 Flow Sensor
- .4 Primary Sensor shall be one of the following as required for project:
 - .1 Glass-filled, six bladed, nylon impeller design with a proprietary non-magnetic sensing mechanism.
 - .2 Glass-filled, six bladed, Tefzel® impeller design with a proprietary non-magnetic sensing mechanism.
- .5 [Sensor sleeve shall be Admiralty Brass, UNS C44300; and mounting adapter shall be Red Brass, UNS C83600.][Sensor sleeve and mounting adapter shall be 316 Stainless Steel.][Sensor sleeve shall be Polyvinyl Chlorine (PVC); and mounting adapter shall be 316 Stainless Steel.]
- .6 Continuous operating temperature of standard versions shall be 221°F [105°C].
- .7 [Brass sensor shall operate at line pressures up to 400 psi at 100°F [38°C].][Stainless steel sensor shall operate at line pressures up to 400 psi at 100°F [38°C].][PVC sensor shall operate at line pressures up to 100 psi at 100°F [38°C].]
- .8 Sensor will operate with pipe size/range 76 to 1020 mm.
- .9 Sensor housing shall be constructed from glass reinforced Polyphenylene Sulfide (PPS).
- .10 Internal Electronics

EMCS Sensors and Transmitters
SECTION 25 35 16

- .11 Enclosure shall be NEMA-6P [IP 68]v
- .12 Standard and CSA versions sensor electronics cable shall be 20' [6 m] of 2-conductor 20 AWG shielded wire provided for connection to display or analog transmitter unit. Rated to 211°F [105°C]. May be extended to a maximum of 2000' [610 m] with similar cable and insulation appropriate for application.
- .13 Outputs:
 - .1 Native
 - .2 Raw pulse
- .14 Sensor Performance
 - .1 Measuring range 0.15 to 9 m/s.
 - .2 Accuracy shall be $\pm 1\%$ of full scale
 - .3 Repeatability shall be $\pm 0.3\%$ of full scale
 - .4 Linearity shall be $\pm 0.2\%$ of full scale
 - .5 Flow sensitivity (standard) is 0.5 to 30 m/s
- .29 Electromagnetic Flow Meter, Liquid, Single-Channel
 - .1 Electromagnetic flow meter is intended for fluid metering in industries including water, wastewater, food and beverage, pharmaceutical and chemical. Measures fluid flow of water or fluids which are highly corrosive, very viscous, contain a moderate amount of solids, or require special handling. No moving parts are in the flow stream. Amplifier can be integrally mounted to the detector or can be remote-mounted. Unit is ideally suited for measuring dynamic, non-continuous flow. In applications where a minimum and/or maximum flow rate must be tracked and monitored, the unit provides pulse signals that can be fed to dedicated batch controllers, PLCs and other more specialized instrumentation.
 - .2 System Components

EMCS Sensors and Transmitters

SECTION 25 35 16

- .1 Metering Tube (Detector): Consists of stainless steel tube lined with a non-conductive material. Energized detector coils around tube create a magnetic field across the diameter of the pipe. As a conductive fluid flows through the magnetic field, a voltage is induced across two electrodes; this voltage is proportional to the average flow velocity of the fluid.
- .2 Signal Amplifier: Consists of unit which receives, amplifies, and processes the detector's analog signal. Signal is converted to both analog and digital signals that are used to display rate of flow and totalization. Processor controls zero-flow stability, analog and frequency outputs, serial communications and a variety of other parameters. Integrated LCD display indicates rate of flow, forward and reverse totalizers and diagnostic messages. Display guides user through programmable routines.
- .3 Operational Requirements
 - .1 The flow meter system shall operate with a pulsed DC excitation frequency, and shall produce a signal output that is directly proportional and linear with the volumetric flow rate of the liquid flowing through the metering tube. The metering system shall include a metering sensor tube (detector), a signal amplifier, and the necessary connecting wiring. The metering system shall have the ability to incorporate a meter mounted or remote mounted amplifier.
- .4 Engineering Units:
 - .1 The signal amplifier shall be program selectable to display the following units of measure: U.S. gallons, imperial gallons, million gallons (U.S.), cubic feet, cubic meters, liters, hector-liters, oil barrels, pounds, ounces or acre feet.
- .5 Operating Principle: Electromagnetic Induction
- .6 Fluid Temperature Range
 - .1 Liner shall be selected according to project requirements with respect to operating temperature range.
- .7 Signal Amplifier
 - .1 The signal amplifier shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of a power interruption.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .2 Automatic zero stability, low flow cut-off, empty pipe detection and bi-directional flow measurement shall be inherent capabilities of the signal amplifier.
- .8 Outputs: The signal amplifier shall provide a total of four digital outputs, one analog output and one digital input.
 - .1 Up to four open collector digital outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, reset output, error alarm and 24V supply.
 - .2 Up to two active digital (24 Volt) outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, preset output, error alarm and 24V supply.
 - .3 Up to two AC solid-state relay outputs, program selectable from the following: Frequency output, flow set point, empty pipe alarm, flow direction, preset amount and error alarm.
 - .4 One analog output programmable and scalable from the following: 0-10mA, 0-20mA, 2-10mA or 4-20mA. Voltage sourced and isolated. Max. loop resistance = 800 ohms.
- .9 One digital input, program selectable from the following: Remote reset, batch reset and positive return to zero.
- .10 Advanced protocol support using Modbus/RTU.
- .11 Control and Programming
 - .1 The signal amplifier shall be programmed via three function buttons. The programming functions shall be available in a user-friendly, menu driven software through the four-line LCD interface. The signal amplifier shall accommodate the following languages: English, German, Czech, French or Spanish.
 - .2 Programmable parameters of the amplifier include, but are not limited to: calibration factors, totalizer resets, unit of measure, analog and pulse output scaling, flow-alarm functions, language selection, low-flow cutoff, noise dampening factor and excitation frequency selection.
 - .3 The signal amplifier shall have a programming option allowing entry of a selected numeric password value for tamper protection.

EMCS Sensors and Transmitters
SECTION 25 35 16

.12 System Performance

- .1 The metering system shall operate over a flow range of 0.03 to 12.0 m/s.
- .2 The metering system shall perform to an accuracy ± 0.25 percent of rate for velocities greater than 0.50 m/s, ± 1 mm/s for velocities less than 0.50 m/s.
- .3 The metering system shall be capable of measuring the volumetric flow rate of liquids having an electrical conductivity as low as 5.0 micromhos per centimeter.
- .4 The system measuring repeatability shall be $<0.10\%$ of full scale.

.13 Indication

- .1 The signal amplifier shall include a four-line, 20-character, backlit LCD interface to display the following values:
- .2 Flow rate in selectable rate units
- .3 Forward totalizer in selectable volume units
- .4 Reverse totalizer in selectable volume units
- .5 Net totalizer in selectable volume units
- .6 Error or alarm messages
- .7 Software revision level

.30 Impeller Flow Sensor and Energy Meter, Liquid, Single-Channel

- .1 Energy measurement system is suitable for metering cold or hot systems. Integral flow sensor, energy calculator and temperature sensors compute energy using flow and temperature differential. BTU system incorporates impeller flow sensor and two temperature probes. One temperature probe is mounted directly in the flow sensor tee, the second temperature probe is installed either the supply or the return line depending on application.
- .2 System Components
 - .1 Integral Hydronic Energy Calculators, Flow Sensor, & Temperature Sensors

EMCS Sensors and Transmitters

SECTION 25 35 16

- .2 Consists of a casting which houses the flow sensor mechanism, a calculator which integrates the flow and temperature data to compute flow/energy rate and total.
- .3 Temperature probes used to measure temperature by correlating the resistance of the RTD element with temperature. Set consists of one to measure liquid in the inlet pipe, and one to measure the liquid in the outlet pipe.
- .4 Standard 5-pin Mini USB Cable
- .5 Cable required to connect flow sensor system to PC for use of commissioning software.
- .6 120 VAC/12V DC Power Supply
- .3 Operational Requirements
 - .1 The system shall be a microprocessor based digital unit, capable of calculating and outputting energy information. Energy information shall be either a scaled pulse output representing energy total or RS-485 output providing complete information (standard feature). The RS-485 shall communicate using either BACnet, MSTP or Modbus RTU.
- .4 Certifications
 - .1 RTD meets IEC751 Class B
 - .2 Electrical Inputs meet RS-485
 - .3 Enclosure shall be NEMA 4X [IP 65]. Sensor housing shall be constructed of PEEK.
- .5 Complete information from RS485 output shall include energy rate, energy total, temperature one, temperature two, temperature differential, temperature mode, flow filter coefficient, temperature filter coefficient, specific heat coefficient, and fluid density coefficient.
- .6 Primary Sensor: Grade 316 stainless steel, non-magnetic impeller design.
- .7 The system shall operate with pipe size ranges 19.05 to 50.8 mm.
- .8 Tee shall be constructed from cast bronze.
- .9 Type of process connection shall be NPT.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .10 Hot liquid sensor shall have continuous operating temperature of 4° to 125°C.
- .11 Chilled liquid sensor shall have continuous operating temperature of -20° to 60°C.
- .12 One temperature probe shall be mounted directly in the flow sensor tee; the second shall be placed on either the supply or the return line depending on the application.
- .13 Scaled pulse output. Solid state switch. Maximum frequency of scaled pulse varies based upon pulse width selected. Pulse width available is 10, 50, 150, 200, 250, and 500mS. Resulting frequency range is 0.01 Hz min. to 100 Hz max.
- .14 Signal can travel up to 610m between flow sensor and connected device depending on cable.
- .15 Industrial Communications (native):
 - .1 BACnet on MS/TP
 - .2 Modbus RTU
- .16 Standard flow measurement range shall be 0.6-6 m/s
- .17 Low flow measurement range shall be 0.09-2.5 m/s
- .18 Accuracy shall be $\pm 2\%$ of full scale
- .19 Repeatability shall be $\pm 0.5\%$ of full scale
- .20 Types of Liquids: Suitable for clean, homogenous, lower-viscosity liquids
- .31 Impeller Flow Sensor, Liquid
 - .1 The flow sensor shall be an in line type with a nonmagnetic, spinning impeller (paddle wheel) as the only moving part. The impeller shall have a UHMWPE, Tefzel®, or Teflon® sleeve bearing. The shaft material shall be tungsten carbide, Zirconia Ceramic, or 316 Stainless Steel. The electronics housing shall have two ethylene-propylene, Nitrile rubber, or Viton® O-Rings and shall be easily removed from the meter body.
 - .2 Certifications
 - .1 Device shall be certified by CSA®

EMCS Sensors and Transmitters
SECTION 25 35 16

- .2 Enclosure shall be NEMA-6P [IP 68]
- .3 Flow Sensor shall be one of the following as required for project:
 - .1 Glass-filled, six bladed, nylon impeller design with a proprietary non-magnetic sensing mechanism.
 - .2 Glass-filled, six bladed, Tefzel® impeller design with a proprietary non-magnetic sensing mechanism.
- .4 Sensor Performance
 - .1 Measuring range 0.15 to 9 m/s
 - .2 Accuracy shall be $\pm 1\%$ of full scale
 - .3 Repeatability shall be $\pm 0.7\%$ of full scale
 - .4 Linearity shall be $\pm 0.7\%$ of full scale
 - .5 Turndown shall be 60:1.
- .5 Continuous operating temperature of standard versions shall be 66°C.
- .6 Tee material shall be Valve Bronze, UNS C83600.

PART 3 - EXECUTION

3.1 INSTALLATION OF SENSORS

- .1 Install sensors according to manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for operating environment.
- .3 Install room temperature sensors on concealed junction boxes properly supported by wall framing.
- .4 Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- .5 Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
- .6 Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m of sensing element for each 1 m² of coil area.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .7 Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- .8 Install outdoor air temperature sensors on north wall at designated location with sun shield.
- .9 Differential Air Static Pressure.
 - .1 Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - .2 Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - .3 Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
 - .4 Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
 - .5 Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
 - .6 Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.
- .10 Smoke detectors, high and low limit thermostats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
- .11 Flow Sensors
 - .1 Insert-style Impeller Flow Sensor, Liquid
 - .1 Follow manufacturer's recommendation for installation and conform to the guidelines provided by the Installation & Operation Manual.
 - .2 Straight pipe requirement for mounting shall be 10 diameters up stream and 5 downstream.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .3 Sensor shall be located with the least possible circumferential displacement from top-center of pipe; any circumferential location in vertical pipes is acceptable.
- .4 Sensor mounted in 50mm tap in either pipe saddle or weld on fitting.
- .5 An insertion depth of 40mm for pipe sizes 65mm and larger is required for accurate flow monitoring.
- .6 Sensor orientation shall be such that flow arrow on sensor is aligned with flow direction.
- .2 Electromagnetic Flow Meter, Liquid
 - .1 Follow manufacturer's recommendation for installation. Installation will conform to the guidelines provided by the Installation & Operation Manual.
 - .2 Straight pipe requirement shall be an equivalent of three diameters on the inlet (upstream) side, and two diameters on the outlet (downstream) side.
 - .3 For best performance, place meter vertically, with liquid flowing upward and meter electrodes in a closed, full pipe.
- .3 Impeller Flow Sensor and Energy Meter, Liquid
 - .1 Follow manufacturer's recommendation for installation.
 - .2 Straight pipe requirement shall be 10 diameters upstream and 5 diameters downstream. Pipe bends, valves, other fittings, pipe enlargements and reductions should not be present in this length of pipe.
 - .3 Apply pipe compound over the first 3 or 4 threads of the mating pipe.
 - .4 Thread the pipe into the sensor tee until hand tight, and then tighten the pipe an additional 1-1/2 turns, using a wrench.
 - .5 System requires isolated 12-24 V AC/DC power supply. To avoid ground fault conditions, power should not be shared with other devices.
 - .6 The RS-485 requires three connections: RS-485+, RS-485- and REF. RS-485 is a high-speed connection and should be wired to meet TIA-EIA-485-A standards.

EMCS Sensors and Transmitters

SECTION 25 35 16

- .7 The pulse output is a simple solid state switch. The switch is not polarity sensitive, however, the maximum voltage and current ratings should not be exceeded.
- .4 Impeller Flow Sensor, Liquid
 - .1 Follow manufacturer's recommendation for installation and conform to the guidelines provided by the Installation & Operation Manual.
 - .2 Straight pipe requirement for mounting shall be 10 diameters up stream and 5 downstream.
 - .3 Tee sensor shall be vertically upright in horizontal locations; any circumferential orientation in vertical installations is acceptable.
 - .4 Sensor orientation shall be such that flow arrow on sensor is aligned with flow direction.

3.2 FLOW SWITCH INSTALLATION

- .1 Use correct paddle for pipe diameter.
- .2 Adjust flow switch according to manufacturer's instructions.

END OF SECTION

EMCS Control Valves

SECTION 25 35 19

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .10 SECTION 25 35 23, EMCS: Control Dampers
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

PART 2 - PRODUCT

2.1 VALVES

- .1 Unless otherwise indicated, hydronic system two and three-way automatic control valves shall be globe-style bodies and have the following characteristics:
 - .1 NPS 2 and Smaller: ANSI Class 250 bronze body, stainless steel stem, brass plug, bronze seat, and a TFE packing.
 - .2 NPS 2-½ and Larger: ANSI Class 125 cast iron body, stainless steel stem, bronze plug, bronze seat, and a TFE V-ring packing.

EMCS Control Valves
SECTION 25 35 19

- .3 Sizing:
 - .1 Two-Position: Line size or size using a pressure differential of 1 psi.
 - .2 2-way Modulating: 5 psig or twice the load pressure drop, whichever is greater.
 - .3 3-way Modulating: Twice the load pressure drop, but not more than 5 psig.
 - .4 Flow Characteristics: 2-way valves shall have equal percentage characteristics; 3-way valves shall have linear characteristics.
 - .5 Close-off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system head pressure for 2-way valves and 150% of the design pressure differential across the 3-way valves.
 - .6 Bodies for valves 3" to 6" shall be iron, cast iron or cast steel with flanged connections and shall be rated for ANSI Class 125 working pressure. Packing shall protect against leakage at the stem.
- .2 Unless otherwise indicated, steam system globe-style valves shall have the following characteristics:
- .1 NPS 2 and Smaller: ANSI Class 250 bronze body; stainless steel seat, stem and plug; and a TFE packing.
 - .2 NPS 2-½ and Larger: ANSI Class 125 [250] cast iron body; stainless steel seat, stem and plug; and a TFE V-ring packing.
 - .3 Sizing:
 - .1 Two-Position: Line size or sized using 10% of inlet gauge pressure.
 - .2 Modulating: 15 psig or less inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 15 psig inlet steam pressure the pressure drop shall be 42% of the inlet absolute pressure.
 - .4 Flow Characteristics: Linear or equal percentage characteristics.
 - .5 Close-off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of operating (inlet) pressure.

EMCS Control Valves
SECTION 25 35 19

- .3 Where specified, ball-style body automatic control valves shall adhere to the following:
 - .1 NPS 3 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, NPT female end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a Tefzel flow characterizing disc.
 - .2 Sizing:
 - .1 Two-Position: Line size or size using a pressure differential of 1 psi.
 - .2 2-way Modulating: 5 psig or twice the load pressure drop, whichever is greater.
 - .3 3-way Modulating: Twice the load pressure drop, but not more than 5 psig.
 - .3 Close-off Pressure Rating: 100 psi. [NPS $\frac{3}{4}$ " and Smaller for Terminal Units: 200 psi.]
 - .4 The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.
 - .5 All control ball valves shall feature characterized flow guides when used for modulating applications.
- .4 Where specified, butterfly control valves shall adhere to the following:
 - .1 NPS 2 to 12: Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. External mechanical methods to achieve this mechanical connection, such as pins or screws, are not acceptable. The shaft shall be supported at four locations by RPTFE bushings.
 - .2 NPS 14 and Larger: Valve body shall be full lugged cast iron 150 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.

EMCS Control Valves

SECTION 25 35 19

- .3 Sizing:
 - .1 Two-Position: Line size or size using a pressure differential of 1 psi.
 - .2 Modulating: [5 psig] or twice the load pressure drop, whichever is greater. Size for the design flow with the disc in a 60° open-position with the design velocity less than 12 feet per second.
- .4 Close-off Pressure Rating: NPS 2" to 12" 200 psi bubble tight shutoff.
- .5 NPS 14" and larger, 150 psi bubble tight shut-off.
- .5 Zone Valves (On/Off, Two-Position Applications):
 - .1 NPS 1 and Smaller: Forged brass body, rated at no less than 300 psi, female NPT union or sweat with a stainless steel stem and EPDM seals.
 - .2 Sizing:
 - .1 Two-Position: Line size or size using a pressure differential of 1 psi.
 - .3 Close-off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system head pressure for 2-way valves and 125% of the design pressure differential across the 3-way valves.
 - .4 The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory.

PART 3 - EXECUTION

3.1 COORDINATION

- .1 Coordinate delivery of control valves to site.
- .2 Clearly tag and mark valves for their purpose and location.
- .3 Supervise Mechanical Contractor in the installation of the control valves ensuring proper valve(s) are located and installed in proper location(s)

END OF SECTION

EMCS Control Dampers
SECTION 25 35 23

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .10 SECTION 25 35 19, EMCS: Control Valves
- .11 SECTION 25 35 27, EMCS: Variable Frequency Drives
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 Definitions

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

PART 2 - PRODUCT

2.1 AUTOMATIC CONTROL DAMPERS

- .1 Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all control dampers with the temperature control submittal.
- .2 Damper leakage ratings shall be certified in accordance with AMCA Standard 500-D.
- .3 Provide any automatic control dampers not specified to be integral with other equipment.
- .4 Provide automatic control dampers as specified herein:

EMCS Control Dampers
SECTION 25 35 23

- .1 Frame construction shall not be less than 14 gauge galvanized steel or extruded aluminum at a minimum 4-1/2" X 1" X 0.125" in thickness.
- .2 Blades shall be single skin and not less than 16-gauge galvanized steel roll formed or extruded aluminum. Blades shall not be over: 8" wide, 48" in length and 72" high.
- .3 All blade edges and top and bottom of frame shall be provided with compressible seals. Side seals shall be compressible stainless steel of the tight-seal spring type.
- .4 Blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5 inches of WC differential pressure. Dampers and seals shall be suitable for temperature ranges of -40 to 180 °F.
- .5 Bearings shall corrosion resistant, molded synthetic sleeve type turning in an extruded hole in the damper frame.
- .6 Axles shall be a minimum of 1/2" diameter and be welded to blade or riveted to blade
- .7 Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6".
- .8 Where ultra-low leakage dampers are specified the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 6 CFM per square foot for dampers in excess of sixteen inches square at 1 inch of WC.
- .9 Individual damper sections shall not be larger than 48" X 60". Provide a minimum of one damper actuator per section.
- .10 All proportional control dampers shall be opposed or parallel blade type as specified and all two-position dampers shall be parallel blade types.
- .11 Combination automatic smoke control dampers, where indicated on the plans, shall conform to the UL555S Leakage Class specified.

PART 3 - EXECUTION

3.1 COORDINATION

- .1 Coordinate delivery of dampers to site.
- .2 Clearly tag and mark dampers for their purpose and location.

EMCS Control Dampers
SECTION 25 35 23

- .3 Supervise Mechanical Contractor in the installation of the dampers ensuring proper dampers(s) are located and installed in proper location(s)

END OF SECTION

**EMCS Variable Frequency Drives
SECTION 25 35 27**

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 SECTION 25 01 12, EMCS: Training
- .2 SECTION 25 05 01, EMCS: General Requirements
- .3 SECTION 25 05 02, EMCS: Submittals and Review Process
- .4 SECTION 25 05 03, EMCS: Project Record Documents
- .5 SECTION 25 10 01, EMCS: Networks
- .6 SECTION 25 10 02, EMCS: Computer Systems, MMI
- .7 SECTION 25 30 01, EMCS: Field Controllers
- .8 SECTION 25 35 13, EMCS: Actuators and Operators
- .9 SECTION 25 35 16, EMCS: Sensors and Transmitters
- .10 SECTION 25 35 19, EMCS: Control Valves
- .11 SECTION 25 35 23, EMCS: Control Dampers
- .12 SECTION 25 90 01, EMCS: Site Requirement Applications & Sequences of Operations

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 DESCRIPTION

- .1 This specification covers variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD panel.
- .2 The VFD shall be UL Type 1 or UL Type 12 as required on the schedule.
- .3 The VFD shall have been evaluated by UL and found acceptable for mounting in a plenum or other air handling compartment.
 - .1 Manufacturer shall supply a copy of the UL plenum evaluation upon request.
- .4 The VFD shall be tested to UL 508C.

**EMCS Variable Frequency Drives
SECTION 25 35 27**

- .1 The appropriate UL label shall be applied.
- .2 When the VFDs are to be located in Canada, C-UL certifications shall apply.
- .5 VFD shall be manufactured in ISO 9001, 2000 certified facilities.
- .6 The VFD shall be CE marked and conform to the European Union ElectroMagnetic Compatibility directive.
- .7 The VFD shall be UL listed for a short circuit current rating of 100 kAIC and labeled with this rating.
- .8 To ensure adequate technical and factory support, VFDs manufactured by others and brand labeled shall not be acceptable.
- .9 The VFD manufacturer shall supply the VFD and all necessary controls as herein specified.
- .10 The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- .1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors.
- .2 The motor current shall closely approximate a sine wave.
- .3 Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.
- .4 When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor.
- .5 VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- .6 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .7 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating.
 - .1 Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.
- .8 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
- .9 The VFD's full load output current rating shall meet or exceed NEC Table 430-150.
- .10 The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 135% of rated torque for up to 0.5 second while starting.
- .11 The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed.
 - .1 This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds.
- .12 A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
- .13 The VFD must be able to produce full torque at low speed to operate direct drive fans.
- .14 The VFD must be capable of connection and disconnection to motor while the VFD is under load.
 - .1 This switching shall be accomplished without interlocks or damage to the VFD.
- .15 An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency.
 - .1 It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .16 Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents.
 - .1 VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
- .17 VFD shall minimize audible motor noise through the use of an adjustable carrier frequency.
 - .1 The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise.
 - .2 VFDs with fixed carrier frequency are not acceptable.
- .18 All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

2.2 PROTECTIVE FEATURES

- .1 A minimum of Class 20 I²t electronic motor overload protection for single motor applications shall be provided.
 - .1 Overload protection shall automatically compensate for changes in motor speed.
- .2 Protection against input transients, loss of AC line or load phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature.
 - .1 The VFD shall display all faults in plain language. Codes are not acceptable.
- .3 Protect VFD from input phase loss.
 - .1 The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition,
 - .2 the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed.
 - .3 This function is independent of which input power phase is lost.
- .4 Protect from under voltage.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.
- .2 The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
- .5 Protect from over voltage.
 - .1 The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.
- .6 The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
- .7 VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal.
 - .1 It shall also include a programmable time delay to eliminate nuisance signal loss indications.
 - .2 The functions after detection shall be programmable.
- .8 VFD shall function normally when the keypad is removed while the VFD is running.
 - .1 No warnings or alarms shall be issued as a result of removing the keypad.
- .9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.
- .10 Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.
- .11 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload.
 - .1 If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
- .12 If the temperature of the VFD's heat sink rises to a critical level, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
- .13 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
- .14 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life.
 - .1 The drive fan speed can be preprogrammed at preset speeds or run in Auto mode.
 - .2 At low loads or low ambient temperatures, the VFD may even turn the fan(s) off even when the VFD is running.
- .15 The VFD shall store in memory the last 10 alarms.
 - .1 A description of the alarm, and the date and time of the alarm shall be recorded.
 - .2 The VFD shall include graphing capability for the last 2 alarms to provide additional diagnostic analysis.
- .16 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve.
 - .1 It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.3 INTERFACE FEATURES

- .1 Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference.
 - .1 It shall be possible to either disable these keys or password protect them from undesired operation.
- .2 There shall be an "Info" key on the keypad.
 - .1 The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
- .3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.
- .4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted.
 - .1 Two levels of password protection shall be provided to guard against unauthorized parameter changes.
- .5 All VFDs shall have the same customer interface.
 - .1 The keypad and display shall be identical and interchangeable for all sizes of VFDs.
- .6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD.
 - .1 To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
 - .2 Keypad shall provide visual indication of copy status.
- .7 Display shall be programmable to communicate in multiple languages including English, Spanish, German, French, Chinese, Portuguese, and Danish.
- .8 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided.
 - .1 These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- .9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD.
 - .1 The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.
- .10 A three-feedback PID controller to control the speed of the VFD shall be standard.
- .11 This controller shall accept up to three feedback signals.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal.
- .2 It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
- .12 The VFD shall be able to apply individual scaling to each feedback signal.
- .13 For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
- .14 The VFD's PID controller shall be able to actively adjust its setpoint based on flow.
 - .1 This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
- .15 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
- .16 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- .17 Five simultaneous meter displays shall be available.
 - .1 They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
- .18 Programmable Sleep Mode shall be able to stop the VFD.
 - .1 When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop.
 - .2 When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .3 To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
- .19 A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation.
 - .1 The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.
- .20 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wc), Kilo Pascals (kPa) or temperature (°C).
- .21 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wc), pressure per square inch (psi) or temperature (°F).
- .22 VFD shall be programmable to sense the loss of load.
 - .1 The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
 - .2 To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

2.4 STANDARD CONTROL AND MONITORING INPUTS AND OUTPUTS

- .1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- .2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
- .3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
- .4 Each relay shall have an adjustable on delay / off delay time.
- .5 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
- .6 Each shall be independently selectable to be used with either an analog voltage or current signal.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .7 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
- .8 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- .9 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
- .10 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status.
 - .1 This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power.
 - .2 It shall be possible to scale the minimum and maximum values of this output.
- .11 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
- .12 It shall be possible to command all digital and analog output through the serial communication bus.

2.5 OPTIONAL CONTROL AND MONITORING INPUTS AND OUTPUTS

- .1 It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
- .2 These modules shall use rigid connectors to plug into the VFD's control card.
- .3 The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
- .4 Modules may include such items as:
 - .1 Additional digital outputs, including relay outputs
 - .2 Additional digital inputs
 - .3 Additional analog outputs
 - .4 Additional analog inputs, including Ni or Pt temperature sensor inputs

EMCS Variable Frequency Drives
SECTION 25 35 27

- .5 It shall be possible through serial bus communications to control the status of all analog and digital outputs of the VFD.
 - .1 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands.
 - .2 It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload.
 - .3 The VFD shall display FIREMODE whenever in firefighter's override mode.
 - .4 Fire-mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- .6 A real-time clock shall be an integral part of the VFD.
 - .1 It shall be possible to use this to display the current date and time on the VFD's display.
 - .2 Ten programmable time periods, with individually selectable ON and OFF functions shall be available.
 - .3 The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates.
 - .4 The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
- .7 All VFD faults shall be time stamped to aid troubleshooting.
- .8 It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
- .9 The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
- .10 The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
- .11 The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 Comparators for comparing VFD analog values to programmed trigger values
- .2 Logic operators to combine up to three logic expressions using Boolean algebra
- .3 Delay timers
- .4 A 20-step programmable structure
- .5 The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of additional constant speed motor starters.

2.6 SERIAL COMMUNICATIONS

- .1 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 - .1 BACnet MS/TP
 - .2 Option board only
- .2 Option boards for the following protocols shall be available:
 - .1 BACnet Expanded
 - .2 Ethernet
 - .3 LonWorks Free Topology (FTP) certified to LonMark standard 3.3
- .3 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD.
 - .1 The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port.
 - .2 It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .4 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

2.7 ADJUSTMENTS

- .1 The VFD shall have a manually adjustable carrier frequency to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
- .2 Four independent setups shall be provided.
- .3 Four preset speeds per setup shall be provided for a total of 16.
- .4 Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
- .5 Each setup shall be programmable for a unique current limit value.
 - .1 If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD.
 - .2 If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
- .6 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
- .7 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- .8 An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
- .9 Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

2.8 OPTIONAL FEATURES

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 All optional features shall be built, mounted and tested by the VFD manufacturer.
 - .1 The VFD manufacturer's warranty shall apply to the entire assembly as shipped.
 - .2 Packages built by third parties and do not carry the VFD manufacturer's warranty shall not be allowed.
 - .3 All options shall carry a UL / C-UL Enclosed Industrial Control Panel label.
 - .4 All panels shall be marked for 100,000 amp short circuit current rating.
- .2 The enclosure rating of the VFD w/ options shall be consistent with the VFD rating of either NEMA/UL type 1 or NEMA/UL type 12, as required for the installation location and/or as called for on the schedule.
 - .1 The package shall include ALL optional devices and shipped as a complete factory tested assembly.
- .3 Three Contactor bypass shall be provided that allows operation of the motor via line power in the event of a failure of the VFD.
 - .1 Motor control selection shall be through either a VFD output contactor or a bypass contactor that is electrically interlocked to ensure that both contactors are not energized simultaneously.
 - .2 A third contactor, the drive input contactor, shall be supplied as standard.
 - .3 This allows the powering of the VFD with the motor off or operating in bypass mode for testing, programming and troubleshooting purposes.
- .4 The Three Contactor bypass shall include the following interface and control features:
 - .1 Mode selection via a four position DRIVE/OFF/BYPASS/TEST switch.
 - .2 DRIVE Mode: Both the drive input and output contactors are closed and the motor is operated via VFD power
 - .3 OFF mode: DRIVE input, drive output and bypass contactors are all open.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .4 Bypass mode: Bypass contactor is closed and motor is operating from line power. Both the drive input and drive output contactors are open for servicing of the VFD without power.
- .5 Test mode: Bypass contactor is closed and the motor is operated from line power. The drive input contactor is closed but the drive output contactor is open. This allows for the testing and programming of the VFD while the motor is operated via line power.
- .5 Contactors shall operate from a 24vdc power supply that shall function off of any two legs of the AC line and shall maintain power on the loss of any one of the AC lines.
- .6 A Bypass pilot light is supplied to indicate that the motor is operating from line power.
- .7 Common start/stop command when operating in either Bypass or VFD mode.
- .8 Selectable Run Permissive logic shall operate in either VFD or bypass operation.
 - .1 When activated, any command to start the motor, in either Hand Bypass, Remote Bypass, Hand VFD or Remote VFD shall not start the motor, but instead close a relay contact that is used to initiate operation of another device, such as an outside air damper.
 - .2 A contact closure from this device shall confirm that it is appropriately actuated and the motor shall then start.
- .9 Bypass package shall include an External Safety interlock that will disable motor operation in either bypass or VFD when open.
- .10 Fire-mode bypass operation shall be standard.
 - .1 When activated via a contact closure, the motor shall transfer to bypass (line power) regardless of the mode selected.
 - .2 All calls to stop the motor shall be ignored.
 - .3 These include the opening of the start command, an external safety trip or the tripping of the motor overload.
 - .4 Fire-mode operation will take precedence over all other commands.
- .11 The bypass must include a selectable time delay of 0 to 60 seconds before the initiation of bypass operation.

EMCS Variable Frequency Drives
SECTION 25 35 27

- .1 When transferring from VFD to bypass modes, the time delay starts after the motor has decelerated to zero speed.
 - .2 This delay allows the EMCS to prepare for bypass operation.
 - .3 Bypass packages that do not include a time delay, or do not include a selectable delay period, will not be acceptable.
- .12 Automatic bypass shall be selectable.
- .1 When active, the motor shall be transferred to line power on a VFD fault condition.
 - .2 The bypass time delay shall be activate prior to this transfer to line power to allow the VFD time to attempt to recover from the fault condition prior to running in bypass.

2.9 PROTECTIVE FEATURES

- .1 Main input disconnect shall be provided that removes power from both the bypass and VFD.
- .2 Main input motor rated fuses that protect the entire package.
- .3 VFD only fast acting input fuses shall be provided. Packages that include only main input motor rated fusing or circuit breaker are not acceptable.
- .4 Overload protection shall be supplied in bypass mode.
- .5 This overload shall supply minimum class 20 protection as well as wide adjustable current setting for complete motor protection when operating on line power.
 - .1 Those overloads that are not class 20 or current selectable will not be acceptable.
- .6 Overload protection shall include phase loss and phase imbalance protection.
- .7 For 460V/600V units 75 Hp and below and 208V/230V units 40 Hp and below, low voltage contactor operation shall be maintained down to 70% of the unit's nominally rated voltage, to ensure VFD operation.
- .8 For 460V/600V units 75 Hp and below and 208V/230V units 40 Hp and below, the VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power.

**EMCS Variable Frequency Drives
SECTION 25 35 27**

- .1 Contactors shall remain closed regardless of which phase is lost to ensure VFD operation.

2.10 LINE/LOAD CONDITIONERS

- .1 VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the options enclosure. Lower levels of impedance will not be acceptable.

2.11 SERVICE CONDITIONERS

- .1 Ambient temperature, continuous, full speed, full load operation:
 - .1 0 to 45°C on Non-Bypass units
 - .2 0 to 40°C on Bypass units
 - .3 5 to 95% relative humidity, non-condensing.
 - .4 Elevation to 1,015 metres without derating.
 - .5 Elevation to 3,300 feet without derating.
 - .6 AC line voltage variation, -10 to +10% of nominal with full output.
 - .7 All power and control wiring shall be from the bottom.
 - .8 All VFDs shall be plenum rated.

2.12 QUALITY ASSURANCE

- .1 To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.
- .2 All optional features shall be functionally tested at the factory for proper operation.

PART 3 - EXECUTION

3.1 START-UP SERVICE

- .1 The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services.
- .2 Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents.

**EMCS Variable Frequency Drives
SECTION 25 35 27**

- .3 Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.
- .4 Harmonic filtering.
 - .1 The VFD supplier shall, with the aid of the buyer's detailed electrical power single line diagram showing all impedances in the power path to the VFDs, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE recommendations after installation.
 - .2 If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the drive supplier quotation.

3.2 WARRANTY

- .1 The complete VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment.
 - .1 The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.
 - .2 The warranty shall be provided by the VFD manufacturer and not a third party.
 - .3 A written warranty statement shall be provided with the submittals.
- .2 The manufacturer shall offer an optional, extended warranty allowing the VFD warranty to be extended to up to 6 years.

END OF SECTION

EMCS: Site Requirement Applications & Sequences of Operations
SECTION 259001

PART 1 - GENERAL

1.1 SEQUENCES OF OPERATION

- .1 VAV Sample with/VPACC
- .2 RTU
- .3 AHU
- .4 Site Requirement Applications

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

**ELECTRICAL
SECTION 26 00 00**

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Work in general includes, but is not limited to, the following:
 - 1. New HVAC equipment connections.
 - 2. New switchgear.
 - 3. New lighting.
 - 4. New lighting controls.
 - 5. New panels.
 - 6. Grounding of equipment.
 - 7. Complete lighting and power system as shown on Drawings and specified herein, including conduit, wiring, circuit breakers, relays, switches, receptacles, and other items necessary for complete and operable systems.
 - 8. Electrical connection of equipment furnished by others as shown on the Drawings.
 - 9. Control wiring and installation and connections of control devices as specified herein.
 - 10. Existing fire alarm devices to remain as shown on the Drawings.

1.03 SITE VISITS, COORDINATION OF CONTRACT DOCUMENTS, VERIFICATION OF DIMENSIONS

- A. Examine existing conditions as applicable. Become acquainted with Specifications and Drawings for all portions of the Project. Notify Project

ELECTRICAL SECTION 26 00 00

Manager of apparent discrepancies and of inconsistency between the Specifications and the existing conditions. Secure and follow Project Manager's instructions. The Drawings serve as working drawings only, indicating diagrammatically the general layout of the systems and their various components and equipment.

- B. Scaled and figured dimensions are approximate and are given for estimate purposes only. Carefully check and verify dimensions and sizes in order to determine if equipment and materials will fit together and if the dimensions of the assembly are compatible with the space provided. Where equipment is furnished by others, verify that dimensions and requirements for assembly are compatible with the space provided before proceeding with the roughing-in connections. Field verifications of locations shown on Drawings are necessary since actual locations, distances, mounting heights, etc., may be affected by field conditions. The right is reserved to make reasonable changes in locations of equipment or other features shown on Drawings prior to rough-in without additional cost to the Owner.
- C. Where apparatus and equipment have been indicated on the Drawings, dimensions have been taken from typical equipment of the class indicated. Carefully check the Drawings to see that the contemplated equipment will fit into the spaces provided, regardless of whether or not it may have been approved for quality and utility as an equal.
- D. Rough in all equipment, fixtures, etc., as designated on the Drawings and as specified herein. The Drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified Drawings. The Contractor shall obtain all certified rough-in information before progressing with any Work for rough-in connections.
- E. Be responsible for providing outlets and services of proper size at the required locations.
- F. Coordinate requirements of equipment furnished by others, prior to ordering and installation.
- G. No allowance will be made for extra expense due to failure or neglect to follow foregoing directives.

1.04 RULES AND REGULATIONS

- A. Materials and installation shall be in accordance with current rules and requirements of California Code of Regulations and local codes and ordinances including, but not necessarily limited to, the current editions of the following:

ELECTRICAL SECTION 26 00 00

1. The California Electrical Code (CEC).
 2. Title 8, Chapter 4, California Code of Regulations (Low Voltage Electrical Safety Orders).
 3. California State Fire Marshal.
 4. California Statewide Qualified Product List (QPL), Title 20.
 5. Design Lights Consortium (DLC).
 6. NEMA (National Electrical Manufacturers Assoc.).
 7. IEEE (Institute of Electrical and Electronic Engineers).
 8. California Green Building Code.
 9. ANSI (American National Standards Institute).
 10. ASTM (American Society for Testing and Materials).
 11. UL (Underwriters Laboratories).
 12. OSHA (Occupational Safety & Health Act) Federal.
 13. Title 24, California Code of Regulations, California Building Code.
 14. NFPA (National Fire Protection Association).
 15. NESC (National Electrical Safety Code).
 16. NECA Standards of Installation.
 - a. NECA/IESNA 500-2006, Standard for Installing Indoor Lighting Systems.
- B. Where these Specifications call for a higher standard than the above-mentioned rules, the Specifications shall govern.
- C. Should there be any direct conflict between the above-mentioned rules and these Specifications, the rules shall govern.
- D. Nothing in the Drawings or Specifications is to be construed to permit Work not conforming to the rules, codes, and regulations.
- E. All materials utilized shall be new and the best of their respective grades or kinds.

1.05 DEFINITIONS

- A. Article 100 of the California Electrical Code shall serve as a guide for definitions.
- B. Industry standard definitions.
- C. Specific Definitions:
1. Concealed: Hidden from sight, as in trenches, chases, hollow construction, above furred spaces, suspended ceilings (acoustical or plastic type), or exposed to view only in tunnels, attics, shafts, crawl

ELECTRICAL
SECTION 26 00 00

spaces, unfinished spaces, or other areas solely for maintenance and repair.

2. Exposed: Not concealed.
3. Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel, a room noted on the "Finish Schedule" with exposed and unpainted construction for walls, floor or ceilings, or specifically mentioned as "unfinished".
4. Finished Spaces: Any space ordinarily visible to the visiting public, including exterior areas.

1.06 RECOGNIZED TEST LAB

- A. All equipment specified or installed under this project shall be listed by a recognized test lab and bear that label of approval.

1.07 PERMITS AND FEES

- A. Procure licenses and permits necessary for the completion of the Work, and inspection and other applicable fees. Before final payment, deliver to the Owner certificates and permits, approved and signed by the authorities having jurisdiction.

1.08 RECORD DRAWINGS

- A. Include under this Work complete and accurate record information both during construction and before final acceptance by the Owner, and costs associated therewith shall be included under this Work.
- B. Obtain from the Project Manager, at cost, a complete, full size set of prints. On these prints, systematically and accurately keep an up-to-date and legible dimensional record of Work installed differently from the location or manner indicated by the Drawings, as well as exact locations of stub-outs and hidden or underground features. Have these Drawings readily available for reference and review. When job status permits, submit them to the Project Manager and amend or correct and re-submit if requested.
- C. When the above information is complete and acceptable, deliver Record Drawings to the Project Manager.

1.09 SUBMITTALS - SUBSTITUTIONS

**ELECTRICAL
SECTION 26 00 00**

- A. Bids shall be based on Drawings and Specifications and references exactly as shown except as substitutions are permitted under terms of the Instructions to Bidders. Acceptance by the Project Manager of a variation or alternate shall not of itself waive other requirements of the Drawings and Specifications.
- B. Before a substitute is used, it shall be equal in quality and utility to the material or make of equipment specified, and furthermore, shall be suitable for the particular application. The decision of the Project Manager as to the quality and utility of the substitute offered shall be final.
- C. When submitting a substitute to a specified item, provide complete data for both the specified item and the substitute. Complete data includes:
 - 1. Catalog cuts with complete dimensions, characteristics, electrical properties, Under-writer's Laboratory listing, harmonics, light output, mounting and support requirements.
 - 2. Calculations, photometrics, system load data, energy effect on system, etc.

If the substitute is not deemed equal in both utility and quality to the specified item, the specified item will be approved and it shall be provided by the Contractor.
- D. Submit in one package complete systematized lists of equipment and Drawings, catalog cuts, brochures, capacity tables and curves, descriptive information, performance data and guarantees and warranties referenced either to applicable Specification paragraphs or to item numbers as shown on the Drawings, or both. Submit six (6) copies.
- E. Do not order or install equipment until submittals have been reviewed and approved.
- F. Where accepted materials or equipment other than is specified or shown on the Drawings require redesign of structural, architectural, electrical or mechanical features or layouts, such changes shall be made by, or at the expense of the Contractor - all subject to complete review by the Project Manager.
- G. Because of the contingencies involved, review and general acceptance of proposed substitutes shall not relieve the Contractor's responsibility under this Work for ensuring in all respects the suitability of such materials and equipment for the particular Project requirements.

**ELECTRICAL
SECTION 26 00 00**

1.10 SHOP DRAWINGS

- A. Prepare shop Drawings of items as required by the Project Manager or by Drawings and Specifications; submit six (6) copies of each to the Project Manager as part of the submittal package, sufficiently in advance of construction, if necessary.
- B. The shop drawings shall be submitted sufficiently in advance of construction to allow time for review and for resubmission, if necessary.
- C. Submit all shop drawings and data at one time for equipment provided under this Section. The complete electrical shop drawings shall be bound in one pamphlet or binder indexed to this Section.
- D. Shop drawing submittals processed are not change orders. The purpose of shop drawing submittals by the Contractor is to demonstrate that the Contractor understands the design concept; he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. If deviations, discrepancies or conflicts between shop Drawings and Specifications are discovered, either prior to or after shop drawing submittals are processed, the design Drawings and Specifications shall control and shall be followed.
- E. Manufacturers' data and dimension sheets shall be submitted giving all pertinent physical and engineering data including weights, cross-sections and maintenance instructions. Standard items of equipment such as receptacles, switches, plates, etc., which are cataloged items, shall be listed by manufacturer.
- F. Index all submittals and reference to these Specifications.

1.11 COMPLETION DATA

- A. Submit completion data to the Project Manager in acceptable quantity and form before requesting a final inspection. Such submittal shall be corrected, amended, or completed before final acceptance of the Work.
- B. Include Record Drawings, maintenance manuals, and data; test results; control and wiring diagrams.

1.12 CUTTING, PATCHING, AND REPAIRING

- A. Cutting, patching, and framing of wood members to accommodate this Work shall be done by the Contractor and shall be in conformance with

ELECTRICAL SECTION 26 00 00

Sections 613 and 617 (F) and (K), Title 24, California Code of Regulations. All such cutting, patching and framing shall be approved by the Project Manager.

- B. Do minor miscellaneous cutting, drilling, and patching necessary and normally required at the time of actually installing this Work. Patching shall be of the same materials, workmanship, and finish as the original or surrounding Work to the complete satisfaction of the Project Manager. Comply with Division-1 CUTTING AND PATCHING Section.
- C. Adequately inform other trades of openings and framing requirements for this Work and provide suitable instructions for establishing locations and sizes of openings or sleeves so that these may be provided in the proper location at the proper time. Concrete shall not be cut, except where approved by the Project Manager.

1.13 SIMILARITY OF MATERIALS

- A. Unless specified otherwise, fixtures, fittings, hangers, and respective type features and equipment, of a similar type or having similar operative or functional features, shall be of the same manufacturer throughout the Project.

1.14 MANUFACTURERS' DIRECTIONS

- A. Follow manufacturers' directions and recommendations in all cases where the manufacturers' equipment or articles are used for this Work. Compliance with the manufacturer's direction is a requirement for that product's listing with a recognized test lab.

1.15 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with Work, carefully check and verify dimensions, etc., on architectural Drawings, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- B. Drawings are essentially diagrammatic, and many offsets, bends, pull boxes, special fittings, and exact locations are not indicated. Carefully study Drawings and premises in order to determine best methods, exact locations, routes, building obstructions, etc., and install apparatus and equipment in available locations. Install apparatus and equipment in manner and locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

**ELECTRICAL
SECTION 26 00 00**

1.16 IDENTIFICATION OF EQUIPMENT

- A. All electrical equipment shall be labeled, tagged, stamped, or otherwise identified in accordance with the following schedule:
1. Branch Circuit Panelboards:
 - a. Panel identification shall be P-Touch $\frac{3}{4}$ " label.
 - b. Circuit directory shall be a two-column, 8-1/2 x 11" sheet attached to the inside of the door. Each odd numbered circuit shall be in sequence in the left column and the even numbered circuit in the right column (e.g., 1, 3, 5..., 2, 4, 6...). Each circuit shall be identified as to the use and room name(s) or area(s). Confirm room names and/or room numbers with the Project Manager prior to project completion. Circuit breaker identification shall be by permanently installed metal numbers or plastic numbers under acrylic plastic. "Paste-on" numbers will not be accepted. Refer to "Panelboards" section for additional requirements.
 2. Distribution Panelboards: Identification shall be with 1" x 4" laminated, white on black, micarta nameplates on each major component, each with name and/or number of unit and other pertinent data as required. Emergency power distribution panels shall be identified with white on red micarta nameplates. Letters shall be no less than 3/8" high.
 - a. Circuit breakers shall be identified by number and name with 3/4" x 1-1/2" laminated micarta nameplates with 3/16" high letters mounted adjacent to circuit breaker or switch.
 - b. Miscellaneous equipment (electrical), such as individually mounted safety switches, starters, step-down transformers, pull boxes, junction boxes, etc., shall be identified by the use of such equipment with P-Touch labels as required.
 - c. In general, the installed nameplates, as herein called for shall also clearly indicate its use, area served, circuit identification, voltage and any other useful data.
 - d. All auxiliary systems, including communications, shall be labeled to indicate function.

**ELECTRICAL
SECTION 26 00 00**

- e. Motor control and motor control centers shall be labeled with the identification given on drawing schedules.

1.17 ARC FLASH LABELING

- A. All panels, circuit breaker enclosures, switchboards and motor control centers shall be labeled with Arc Flash Warning Stickers.

1.18 CLOSING IN OF UNREVIEWED WORK

- A. Do not allow or cause any of this Work to be covered up or enclosed until it has been reviewed by the Project Manager. Should any of this Work be enclosed or covered up before such review, uncover the Work and make repairs with such materials as may be necessary to restore the Work and that of the other trades to its original and proper condition at no additional cost to the Owner.

1.19 SAFETY PRECAUTIONS

- A. It is intended that within the scope of this Work during construction and until final acceptance, strict attention be given to matters pertaining to public safety and to safety of the construction workers and complementing personnel; and to other health and building safety requirements as specified and indicated including, but not limited to: Protection of openings in fire-rated construction; clearances from and/or protection of combustibles; proper securement for fixtures, equipment materials; method of performing the Work, operational and safety check of electrical devices, etc.; erection and maintenance of suitable barriers, protective devices, lights and warning signs and adequate provisions for storage and protection of Work, materials and equipment.
- B. It is understood that the responsibility for the proper attention to the above stipulations is included under this Work.

1.20 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS

- A. All electrical wiring including power wiring and control wiring (except as specified under Automatic Temperature Control), including raceways, wiring, outlet and junction boxes, and labor for installation of the wiring and equipment shall be included in this section of the Specifications.
- B. All control devices, and starters not in motor control centers, for equipment furnished under the Air Conditioning section (except as specified under Automatic Temperature Control paragraph), Plumbing section, Fire

**ELECTRICAL
SECTION 26 00 00**

Sprinkler or Lawn Sprinkler section are to be furnished under that particular section and installed under this section.

- C. Wiring diagrams complete with all connection details shall be furnished under each respective section.
- D. Coordinate requirements and locations for all equipment prior to ordering and installation.
- E. Comply with requirements of Article 430 of the California Electrical Code.

1.21 MOUNTING

- A. Provide materials and accessories necessary to properly mount and secure equipment furnished and/or installed under the electrical Work. This includes but is not limited to such items as conduit, outlets, junction boxes, switches, relays, disconnect switches, lighting fixtures, cabinets, and transformers.
- B. Inserts and Anchors shall be:
 - 1. Furnished and installed for support of Work under this Division.
 - 2. Adjustable concrete hanger inserts installed in new concrete work as manufactured by Hilti or as approved.
 - 3. Installed in locations as approved by Project Manager.
 - 4. Expandable lead type anchors installed in existing concrete with minimum surface damage, as manufactured by Hilti.
 - 5. Toggle bolts, or "molly anchors", where installed in concrete block walls.
 - 6. Complete with 3/16" or heavier steel backup plate where used to support heavy items. Through-bolts or backup plate shall be concealed from view, except as otherwise indicated.
- C. Mounting of equipment that is of such size as to be freestanding and that equipment which cannot conveniently be located on walls, such as motor starters, etc., shall be rigidly supported on a framework of galvanized steel angle, Unistrut or as approved.

ELECTRICAL
SECTION 26 00 00

- D. Furnish and install sleeves for the installation of Work under all sections of this Division. Sleeves through floors, roof and walls shall be as described in conduit section.

1.22 MOUNTING HEIGHTS

- A. Receptacles shall be mounted no lower than 15" to the bottom of the device.
- B. Switches and lighting control stations shall be mounted no higher than 48" to the top of the device.
- C. Overcurrent devices and circuit breakers or disconnect switches shall be mounted no higher than 6 feet-7 inches.
- D. Refer to the Drawings for specific mounting heights.

1.23 ACCESSIBILITY

- A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the project.
- B. All required access doors or panels in walls and ceilings are to be furnished and installed as part of the Work under this Division.
- C. Provide doors which pierce a fire separation with the same fire rating as the separation.
- D. Refer to "Finish Schedule" for types of walls and ceiling in each area and architectural Drawings for rated wall construction.
- E. Coordinate Work of the various sections to locate specialties requiring accessibility with others to avoid unnecessary duplication of access doors.

1.24 FIRE-RATED PENETRATIONS

- A. All penetrations in fire-rated assemblies shall be accomplished using a UL listed method and materials.
- B. Fire-rated assembly penetrations shall be accomplished per details on the Drawings.

1.25 FLASHING

**ELECTRICAL
SECTION 26 00 00**

- A. Flash and counterflash all conduits penetrating roofing membrane.

1.26 TESTS

- A. Perform electrical tests as required or directed. Provide materials, labor, and equipment necessary for performances of these tests, and at completion of the Work perform a complete "in-service" operation of the entire electrical and power system to show compliance with the Drawings and Specifications. Replace Work showing faults under tests without additional cost to the Owner. Test system voltage at switchboards at completion of Work and provide a written report to the Project Manager.

1.27 EQUIPMENT LISTS AND MAINTENANCE MANUALS

- A. Prior to completion of job, Contractor shall compile a complete equipment list and maintenance manual. The equipment list shall include the following items for every piece of material and equipment supplied under this section of the Specifications.
 - 1. Name, model and manufacturer.
 - 2. Complete parts Drawings and list.
 - 3. Local supply for parts and replacement and telephone number.
 - 5. All tags, inspection slips, instruction packages, etc. removed from equipment as shipped from the factory, properly identified as to the piece of equipment it was taken from.
- B. Maintenance manuals shall be furnished for each applicable section of the Specifications, shall be suitably bound with hard covers, and shall include all available manufacturers' operation and maintenance instructions, together with as-built Drawings and lists hereinbefore specified and other diagrams and instructions necessary to properly operate and maintain the equipment. The equipment lists and maintenance manuals shall be submitted in duplicate to Architect for approval not less than 10 days prior to the completion of the job. The maintenance manuals shall also include the name, address and phone number of the General Contractor and all subcontractors involved in any of the Work specified herein. The maintenance manuals shall be finally provided in four copies.

1.28 CLEANING

**ELECTRICAL
SECTION 26 00 00**

- A. During construction on a daily basis, and upon completion of the Work, remove from the site all debris and excess materials, tools, and removed items, resulting from this Work. Clean equipment, including lighting fixtures, free of dust, dirt, grease, paint, etc.

1.29 SALVAGE

- A. Deliver salvaged equipment and material deemed salvageable by Project Manager to location designated by Project Manager. Remove other removed material and equipment from site.

1.30 GUARANTEE

- A. Leave the entire installation in complete working order, free from defects in materials, workmanship or finish. Guarantee to repair or replace parts that may develop defects due to faulty materials, equipment, or workmanship within a period of one year after the Work is accepted by the Owner. Also, guarantee to repair or replace with like materials, other existing Work in the building damaged from or during the repair of any such defective equipment, materials, or workmanship.

1.31 INSTALLERS QUALIFICATIONS

- A. Installer must have electrical certification per California Labor Code Section 3099.2.
- B. All work described in the Electrical Specifications and shown on Electrical Drawings shall be performed by California State Certified Electricians.
- C. All electrical foremen shall have a minimum of 500 hours of documented classroom training.
- D. All electrical foremen shall have a minimum of 3,000 hours of documented on-the-job training.
- E. At the time equipment submittals are made, provide copies of State Certification and training documents for electricians working on this project.

PART 2 – PRODUCTS AND EXECUTION

2.01 GROUNDING

- A. Grounding shall be executed in accordance with applicable codes and regulations of the State of California, California Electrical Code and local

ELECTRICAL SECTION 26 00 00

authorities having jurisdiction as well as any additional provisions specified or shown on Drawings.

- B. Grounding bushings shall be used wherever conduits are grounded. Feeder conduits to panels and air conditioners shall have grounding bushings.
- C. Grounding conductors should be located to permit, the shortest and most direct path to ground. Connections shall be readily accessible for inspection and connections shall not be permanently concealed in floors or walls.
- D. Non-current carrying metallic parts of electrical equipment and raceways shall be securely grounded to the common system ground. In all locations, ground conductors shall be run through conduits and shall be securely bonded to the conduit at the entrance and exit. The conduit for the grounding conductors shall be continuous from the point of attachment to cabinets or equipment to the grounding electrode, and shall be securely fastened to the ground clamp fittings.
- E. Ground connections to equipment shall be made with an approved type of exothermic weld or shall be bolted or clamped to equipment or conduit. Sheet metal strap types of ground clamps shall not be used. Contact surfaces shall be thoroughly cleaned and bright before connection is made so as to ensure a good metal to metal contact.
- F. Where nonmetallic conduit is used, ground shall be achieved through use of a separate, green-insulated, copper, code-size, ground conductor included in the conduit.
- G. Bonding of cold water piping system shall be achieved at the service entrance. A copper saddle shall be installed over the copper pipe at the location of the clamp to avoid damage to the pipe.

2.02 CONDUIT

- A. Rigid Steel Conduit:
 - 1. Rigid steel conduit shall have zinc coated exterior, zinc or enamel interior, standard weight, zinc coated couplings, locknuts and bushings and shall bear the U.L. label. Rigid conduit shall not be installed underground.
 - 2. Use rigid conduit only for exposed exterior conduit runs, wherever subject to physical damage, or where specifically called for on the Drawings or required by a serving utility.

ELECTRICAL
SECTION 26 00 00

3. Intermediate metallic conduit (I.M.C.) may be used in lieu of rigid steel conduit.

B. Electrical Metallic Tubing:

1. Electrical metallic tubing (E.M.T.) shall bear the U.L. label and shall be zinc coated thinwall conduit with zinc-coated couplings and connections. "Indent" type fittings shall not be used.
2. E.M.T. may be used where rigid, flexible or non-metallic conduit is not required.
3. E.M.T. shall be used for interior dry locations. EMT shall be used where no specified conduit type is called for on the Drawings.

C. Flexible Metallic Conduit:

1. Flexible metallic conduit shall be galvanized steel and bear the U.L. label. Fittings for flexible conduit shall be squeeze type. Screw-in connectors and other connectors that decrease the interior diameter of the conduit shall not be used unless specifically approved by the Project Manager.
2. Liquid-tight flexible conduit shall bear the U.L. label and be plastic jacketed moisture and oil resistant with oil and vapor tight connectors.
3. Use flexible conduit for final connection to equipment where vibration may injure direct conduit connection. It may be used for indoor dry locations, for fixture whips not to exceed 72 inches and in other locations where structural conditions will not permit the use of EMT not to exceed six feet, only if approved by the Project Manager.
4. Use liquid-tight flexible conduit in lieu of flexible conduit for wet, damp, or outdoor areas or where weatherproof flexible conduit is called for on the Drawings or by code.

D. Plastic Conduit: Plastic conduit shall not be used on this project.

E. Installation of Conduit:

1. Exposed/Concealed Conduit:
 - a. Provide secure mounting facilities for conduits. Wire or plumbers tape shall not be used for hanging conduit. Strap

ELECTRICAL
SECTION 26 00 00

shall be factory made of the one hole malleable iron or two-hole galvanized clamp type.

- b. Provide expansion couplings wherever conduits cross expansion joints.
- c. Run conduit at right angles or parallel to structural members, walls, floors and ceilings. Where several conduits are run together or suspended, they shall be hung on Unistrut trapezes with minimum 3/8-inch rod hangers.
- d. Cut ends of conduit square and ream to remove burrs or sharp edges. Terminate conduits properly with bushings, locknuts, etc. Terminate one (1) inch and larger conduits with insulated bushings.
- e. Render conduits projecting through the roofing watertight by proper flashings. Securely fasten a sheet metal cap and tighten band or storm collar to the conduits. Extend flashing a minimum of six (6) inches in all directions. Coordinate and install roof flashing for conduits to the satisfaction of the Project Manager.
- f. All conduit runs shall have a code size insulated grounding conductor.
- g. Pull wires shall be installed in empty conduits including telephone conduits and stub-outs, No. 12 AWG, type "THWN" insulated copper wire or 1/8-inch polyethylene rope shall be used.
- h. Flexible conduit connections shall comply with NEC Section 350-22.
- i. Provide Dura Block or similar support for roof-mounted conduits.

2.03 OUTLET, JUNCTION AND PULL BOXES

- A. Outlet boxes and junction boxes shall be galvanized one-piece pressed steel, knockout type. The size of each box shall be determined by the number of wires or conduits or size of conduits entering the box, but shall not be less than 4" square and 1-1/2" deep unless otherwise noted. All boxes shall be UL listed.

**ELECTRICAL
SECTION 26 00 00**

- B. Minimum box size for data and telephone outlets shall be 4" square and 2-1/8" deep.
- C. Install wood blocking for outlet boxes in a rigid, workmanlike manner using new material where wood studs are used. Provide rigid support to avoid twisting of outlet boxes where steel studs are used. Boxes shall be secured such that they are level and plumb.
- D. Locknuts shall be used on both sides of conduit connections to box or panel, in addition to bushing. Where a larger size opening occurs than size of conduit, use reducing washers.
- E. Any unused, removed knockouts shall be filled with a K.O. cover.
 - 1. Provide bonding or grounding from metal conduit terminating in junction with concentric KO's.
 - 2. Install boxes and rings such that finished installation is flush with finished surface.

2.04 PLATES AND DEVICE COVERS

- A. Plates for switches, receptacles, telephone and blank outlets shall be stainless steel, Hubbell 302/304 alloy or Legrand "S" line, unless otherwise noted. Plates shall be engraved per Drawings or as covered under the Article of this Specification titled "Identification of Equipment".

2.05 RECEPTACLES

- A. Duplex convenience outlets shall be specification grade, backwire, three wire, NEMA #5-20R, self-grounding type, 20 ampere, 125 volt parallel slots, polarized, in white. Additional receptacles shall be as indicated on the Drawings. Receptacles shall be Hubbell #5253W.
- B. Receptacles indicated weatherproof shall have lift cover plates that are weatherproof "while in use" Hubbell/Taymac expandable flat ML450W or equal.
- C. Ground fault current interrupter receptacles shall be self-testing, Hubbell #GFR5352WST.
- D. Outdoor ground fault circuit interrupter receptacles shall be Hubbell #GFW RST 20W or equal.
- E. USB receptacles shall be Hubbell #USB8200W or equal.

ELECTRICAL
SECTION 26 00 00

2.06 LIGHTING SWITCHES

- A. Line voltage lighting switches shall be specification grade, quiet type, 20 amp, 120/277 volt A.C. white handled, unless otherwise noted. Switches shall be Hubbell #CS1221W.
- B. Dimmers shall be specification grade 20 amp, 120/277 volt, white. Specific attributes of dimmers: types, loads, configuration, shall be as shown on the drawings. Dimmers shall match the drivers in the light fixtures that they feed.
- C. A neutral conductor shall be routed to each switch and dimmer location.

2.07 WIRE AND CABLE

- A. 600 Volt Conductors:
 - 1. Conductors shall be copper and delivered to the site in their original, unbroken packages plainly marked or tagged with U.L. label, size, kind, insulation, name of manufacturer and trade name of the wire.
 - 2. Type "THWN/THHN", 600-volt insulation shall be used for all locations.
 - 3. Minimum size conductor shall be #12.
 - 4. Conductors shall be stranded.
 - 5. Ground conductors shall be bare copper or have green insulation.
 - 6. 220 volt and 277 volt circuits shall have separate neutrals.
- B. MC Luminary Cable:
- C. MC Luminary cable may be used for line voltage and 0-10 volt wiring between light fixtures and dimmers.
- D. MC Luminary cable shall be UL listed.
 - 1. MC Luminary cable shall be properly supported along its route between fixtures and dimmers.
 - 2. Acceptable manufacturers: Manufacturers shall be one of the following, but not limited to:
 - a. AFC

**ELECTRICAL
SECTION 26 00 00**

- b. Southwire
 - c. General Cable
3. MC Cable sizes shall be as shown on the Drawings.
4. Installation:
- a. Conductors shall be continuous between outlets or junction boxes and no splices shall be made except in outlet boxes, pull boxes, panelboard gutters or handholes.
 - b. Joints, splices and taps No. 10 or smaller (including fixture pigtails) shall be connected with "floating spring" type connectors. No. 8 and larger shall be connected with solderless connectors of 100% electrolytic copper. Split-bolt connectors are not acceptable.
 - c. Tighten pressure type lugs on panels and equipment, and then retighten 24 hours or more later after energizing. Provide written report of torque values on lugs.
 - d. Oil or grease shall not be used when pulling conductors. Use U.L. approved cable lubrication only.
 - e. Lace or train conductors neatly in panels, cabinets and equipment. Use plastic wire ties to route conductors at edge of enclosure away from overcurrent devices.
 - f. Branch circuits shall be color coded in compliance with Section 210-5 of the California Electrical Code. Colored tape is not acceptable.
 - g. All wiring, both line and low voltage, shall be installed in conduit unless otherwise noted.
 - h. Conductors from different panels or from different power sources shall not be installed in the same conduit, junction box, gutter, or raceway.
5. Tag:
- a. Branch circuits shall be left tagged with circuit numbers in gutters and junction boxes where unused circuits terminate.
 - b. Feeder conductors shall be tagged as phase "A" or "B" or "C".

ELECTRICAL SECTION 26 00 00

- c. The method of tagging shall be with adhesive preprinted tape numbered or lettered wrap around tags. Colored tape is not acceptable.
 - d. Tagging shall be applied after wire is installed in conduit.
 - e. Feeders in panel or equipment shall be tagged by phase letter in each panel or equipment.
 - f. Where it is impractical to use printed markers on certain wires or cables, use blank tape with identification marked thereon with indelible pen or pencil.
6. Color Coding for Phase Identification: Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<u>208y/120Volts</u>	<u>Phase</u>
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground

2.08 DISCONNECT SWITCHES

- A. Non-fusible or fusible as shown on the Drawings, heavy duty, 250 or 600 volts as required, NEMA Type 1 enclosure, except where WP is indicated or required by code, use NEMA Type 3R enclosure.

2.09 LIGHTING FIXTURES

- A. Lighting fixtures shall be of manufacture and type as specified in the Fixture Schedule, and shall have all parts and fittings necessary to completely and properly install the fixture. Fixtures of the same type shall be of one manufacturer and of identical finish and material.
- B. Lighting fixtures shall bear Underwriter's Laboratories labels. Interior light fixtures shall be on the California Energy Commission approved list. Exterior light fixtures shall be on the DLC list.
- C. Fixtures shall be furnished and installed as indicated on the Drawings, including hangers, glassware, auxiliary equipment, drivers, adapters, connectors for continuous installation, etc.

ELECTRICAL
SECTION 26 00 00

- D. Each fixture shall be wired with conductors suitable for the voltage, current and temperature to which the conductors will be subjected.
- E. If excessive driver flicker develops within 12 months after installation, the condition shall be corrected at no charge to the Owner. Flickering of the LED or failure of an LED array within 12 months of substantial completion shall also be corrected at no charge to the Owner.
- F. Proper LEDs of type, size, color temperature and wattage indicated shall be furnished and installed in each fixture and shall be manufactured by Phillips, Sylvania, Cree, Sora or Bridgelux. The Contractor shall replace LED arrays which have been burned out prior to final completion. Clean dust, dirt, fingerprints and grease from fixtures before final completion.
- G. Install trims, reflectors, lenses and diffusers with care. Wear cloth or surgical gloves when installing these to avoid leaving fingerprints.
- H. Follow manufacturer's installation instructions when installing light fixtures.

2.10 LED LAMPS

- A. Any LED lamps used shall be JA8 compliant.
- B. LED lamps shall be UL listed.
- C. LED lamps shall be tested for use in the fixtures they will be installed in.
- D. LED lamps shall not cause fixtures to overheat or lamps to prematurely fail.

2.11 PANELBOARDS

- A. Section Includes:
 - 1. Power Distribution Panelboard: Furnish and install distribution panelboard(s) as specified herein and where shown on the associated schedules on Drawings.
 - 2. Lighting and Appliance Panelboard: Furnish and install lighting and appliance panelboard(s) as specified herein and where shown on the associated schedules on Drawings.
- B. References: The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following Specifications.

**ELECTRICAL
SECTION 26 00 00**

1. NEMA PB-1 - Panelboards.
2. NEMA PB-1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. NEMA AB 1 - Molded Case Circuit Breakers.
4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. UL 50 - Enclosures for Electrical Equipment.
6. UL 67 - Panelboards.
7. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures.

C. Power Distribution Panelboards: (Square D I-Line, no equal)

1. Interior:
 - a. Shall be rated 600 VAC. Continuous main current ratings as indicated on associated schedules on Drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
 - b. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated schedules on Drawings not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 rms symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
 - c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
 - d. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 through 600 amperes shall be plated copper. Bussing rated 800

ELECTRICAL
SECTION 26 00 00

amperes and above shall be plated copper. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel-mounting pan by fasteners employing the use of a tamper-resistant warning label.

- e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
 - f. Equipment ground bar shall be insulated or bonded as shown on the Drawings. Ground bar shall be copper. Solid neutral shall be equipped with a full capacity grounding strap for service entrance applications. Gutter-mounted neutral will not be acceptable.
 - g. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be provided. Leveling provisions shall be provided for flush mounted applications.
 - h. Arc Flash labeling shall be provided in accordance with Section 1.18 of these specifications.
 - i. Panelboard lugs shall be tightened with a torque wrench to values listed on the equipment.
2. Molded Case Circuit Breakers - Mains and Branches:
- a. Common Characteristics:
 - 1) Circuit breakers shall be constructed in accordance with the following standards:
UL 489 Federal Specification W-C-375B/GEN
NEMA AB1 CSA 22.2, No. 5-M91
IEC 157-1 BS 4752
 - 2) Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength. Current-carrying components shall be completely isolated from the handle and the accessory mounting area.

ELECTRICAL
SECTION 26 00 00

- 3) Circuit breakers shall have an overcenter, trip-free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
- 4) Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
- 5) Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
- 6) Breaker faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIR ratings.
- 7) Circuit breakers shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
 - (a) Circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Auxiliary Switch, Alarm Switch, Ground Fault Shunt Trip, Electrical Operators, Cylinder Locks, Mechanical Lugs Kits, Compression Lugs Kits, and Handle Accessories.
- 8) Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable. Lugs shall be torqued with a torque wrench to the value listed on the circuit breaker.
- 9) Two- and three-pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker, which allows the

ELECTRICAL
SECTION 26 00 00

user to simultaneously select the desired trip level of all poles.

- 10) Standard circuit breakers up to 250 amperes at 600 VAC shall be UL Listed with HACR ratings.
- 11) Enclosures:
 - (a) Type 1 Boxes:
 1. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvanized steel will not be acceptable.
 2. Boxes shall have removable blank endwalls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
 3. Maximum enclosure dimensions shall be 42 in. wide and 9.5 in. deep.
 - (b) Type 1 Trim Fronts:
 1. Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electro-deposited over cleaned phosphatized steel.
 2. Trim front shall be [4-piece surface] [1-piece with door] [hinged 1-piece with door] available in [flush] [surface] mount. Trim front door shall have rounded corners and edges free of burrs. A clear plastic directory cardholder shall be mounted on the inside of the door.
 3. Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. Two (2) keys shall be provided with each lock.
 - (c) Type 3R, 4, 4X and 12:

**ELECTRICAL
SECTION 26 00 00**

1. Enclosures shall be constructed in accordance with UL 50 requirements. Endwalls shall be welded and sealed. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
2. All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional trunk type latches. A clear plastic directory cardholder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. Two (2) keys shall be provided with each lock.
3. Maximum enclosure dimensions shall not exceed 42 in. wide and 12.95 in. deep.

D. Lighting and Appliance Panelboard: (Square D NQOD, no equal)

1. Interior:
 - a. Shall be rated for 240 VAC/48 VDC maximum. Continuous main current ratings, as indicated on associated schedules, not to exceed 600 amperes maximum.
 - b. Minimum short circuit current rating: As indicated on schedules in rms symmetrical amperes at 240 VAC.
 - c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be copper. Bussing rated for 600 amperes shall be copper as standard construction. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and G.
 - d. All current-carrying parts shall be insulated from ground and phase-to-phase by Noryl high dielectric strength thermoplastic or equivalent.

**ELECTRICAL
SECTION 26 00 00**

- e. Split solid neutral shall be plated and located in the mains compartment up to 225 amperes so all incoming neutral cable may be of the same length.
- f. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.
- g. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
- h. Interiors shall be field converted for top or bottom incoming feed. Main and sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
- i. Panelboard lugs shall be tightened with a torque wrench to values listed on the equipment.
- j. Arc Flash labeling shall be provided in accordance with Section 1.18 of these specifications.

2. Main Circuit Breaker:

- a. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
- b. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker, which allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

ELECTRICAL
SECTION 26 00 00

- c. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
- d. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
- e. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable. Lugs shall be torqued with a torque wrench to the value listed on the main circuit breaker.

3. Branch Circuit Breakers:

- a. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules.
- b. Molded case branch circuit breakers shall have bolt-on type bus connectors.
- c. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
- d. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF.
- e. The exposed faceplates of all branch circuit breakers shall be flush with one another.
- f. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lugs shall be torqued with a torque wrench to the value listed on the main circuit breaker.

4. Enclosures:

**ELECTRICAL
SECTION 26 00 00**

- a. Type 1 Boxes:
 - 1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvanized steel will not be acceptable.
 - 2) Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
 - 3) Box width shall be [20 in wide] [14 in wide] [8.625 in wide - NQOB column width only].
- b. Type 1 Fronts:
 - 1) Front shall meet strength and rigidity requirements per UL 50 standards. Fronts shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
 - 2) Fronts shall be hinged 1-piece with door. Mounting shall be as indicated on associated schedules.
- c. Type 3R, 3S, 5, and 12:
 - 1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
 - 2) All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional trunk type latches. All lock assemblies shall be keyed alike. Two (2) keys shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.
 - 3) Maximum enclosure dimensions shall not exceed 20 in. wide and 6.5 in. deep.

2.12 SURGE PROTECTIVE DEVICES (SPD) (TVSS)

- A. Surge protective devices shall be panel integrated.
- B. SPDs shall be provided and installed in the panel by the manufacturer.

ELECTRICAL
SECTION 26 00 00

- C. SPD size/rating shall be as shown on the Drawings.
- D. SPDs shall be UL listed.
- E. Where independent SPDs are used, they shall be installed adjacent to the equipment they serve. The conductor length from the circuit breaker to the SPD shall be minimized.

2.13 MAIN SWITCHBOARD "MSB"

- A. The main switchboard shall have a dead front, dead rear with floor standing standardized sections, including underground pull section, metering and distribution section. The bus size and circuit breaker trip settings shall be as indicated on the Drawings. Circuit breakers shall be provided with means for padlocking in the "Off" position. Sections shall be provided with full height bussing. The switchboard shall have facilities for the power company's meters and test apparatus. Sequence of metering shall be as required by the serving utility company. All sections shall be finished in baked grey enamel. Bussing shall be copper. Ground bus and solid neutral shall be provided. Provide plastic laminated nameplate. Support switchboard in accordance with manufacturer's requirements. Provide all required seismic bracing.
- B. Main circuit breaker shall be listed and marked for service entrance.
- C. Circuit breakers shall be bolt-on type, plastic molded case, trip free with quick-make, quick break operating mechanism.
- D. The switchboard sections shall be constructed to conform to the latest sections of applicable IEEE Standards and ANSI Standards. The circuit breakers shall have short-circuit AIC ratings as indicated on the Drawings.
- E. Provide plastic, engraved, laminated nameplates for switchboard identification as well as each circuit breaker. Provide a separate plastic, engraved, laminated nameplate with the meter's address.
- F. The main switchboard shall have an arc flash label in accordance with Part I, 1.18 Arc Flash Labeling.

END OF SECTION

EARTHWORK

SECTION 31 22 00

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Application of water as required for compaction or dust control;
 - 3. Importing or removal of soil as required to complete the work;
 - 4. Preparation of sub-grade below walks and paving;
 - 5. Clean up.

1.02 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Work shall be performed in strict compliance with laws, ordinances, or regulations that govern this work.
- B. Project Record Documents:
 - 1. Any deviations from the work shown on the contract documents shall be clearly indicated on the project record documents.
 - 2. Deviations must receive approval by the Architect and DSA.

PART 2 PRODUCTS

1.01 MATERIALS

- A. Earth:
 - 1. Filling and back-filling earth shall be clean and essentially granular with sufficient silt and clay binders.
- B. Imported Fill:
 - 1. If it becomes necessary to import materials from offsite to complete the site grading, import soils shall consist of essentially granular, silty sands with low expansion potential and free of grasses, weeds, debris, rocks larger than 4" in maximum dimension and soluble sulfates in excess of 200 parts per million. Import fill shall contain sufficient silt and clay binders to render them stable in footing trenches and capable of maintaining specified elevation tolerances during paving operations.
 - 2. Any earthen materials proposed to be brought onto the school sites are subject to testing to verify they are in compliance with Dept. of Toxic Substance Control (DTSC) standards. Owner shall determine if testing of materials is required prior to any materials being brought onto the site. Testing of materials may take up to two weeks to verify compliance with DTSC standards.

**EARTHWORK
SECTION 31 22 00**

PART 3 EXECUTION

3.01 EXAMINATION

- A. Contractor shall thoroughly examine the project site prior to submitting his bid to familiarize himself with the conditions of the site and the conditions in which he will be required to work.
- B. Contractor shall thoroughly examine contract documents prior to bid.
 - 1. Documents do not necessarily indicate a balanced site.
- C. Contractor shall familiarize himself with the locations of utilities found onsite and shall protect utilities not shown to be removed.
 - 1. Coordinate excavations near existing utilities with utility companies.

3.02 PROTECTION

- A. Contractor shall protect all adjacent properties from damage resulting from the work of this Section.
- B. Contractor shall protect the work of other trades from damage resulting from the work of this Section.
 - 1. Layout or survey markers shall be carefully maintained.
 - a. Damaged markers must be replaced at the contractor's expense.
- C. Provide and maintain proper barricades or barriers to ensure safety of workers and the general public.
 - 1. Provide dusk-to-dawn warning lights at hazards adjacent to public access.
 - 2. Protect existing concrete walks, curbs, and other permanent structures that are to remain.
 - a. Repair or replace damaged items to the satisfaction of the Architect.
- D. Contractor shall take precautions to avoid loss of soil or debris during transit.
- E. Underground Utilities:
 - 1. Maintain all underground utilities, unless noted otherwise.
 - a. Comply with utility company requirements.
 - 2. Notify Owner and utility company of any utilities to be cut off, modified, or relocated.
 - a. Comply with utility company requirements.
- F. Take necessary precautions to guard against water accumulation in trenches, under buildings, or on adjacent property during the course of this work.
- G. Take necessary precautions to guard against erosion of the project site or adjacent property during the course of this work.

**EARTHWORK
SECTION 31 22 00**

3.03 QUALITY CONTROL

- A. Tolerances:
 - 1. Variation from indicated grades may not exceed 1/10 of a foot.
- B. Certification of Grades:
 - 1. Contractor shall hire a California state licensed civil engineer or surveyor to certify that the grades established during the earthwork comply with the requirements of the contract documents.
 - 2. Contractor shall deliver to Owner a 1"=30'-0" scale as-graded reproducible Mylar plan.
 - a. Plan shall be produced in a professional manner.
 - b. Plan shall show as-graded elevations.
 - c. Plan shall be stamped and signed by the civil engineer or land surveyor hired by the Contractor to certify the grading.
 - 3. The Owner reserves the right, at their own discretion, to hire an independent civil engineer to perform a survey of the project site to confirm the accuracy of the grading work.
- C. Field Testing:
 - 1. Field density testing shall be performed as directed by the Soils Engineer.

END OF SECTION

**ASPHALTIC CONCRETE PAVING
SECTION 32 12 16**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Layout of work;
 - 3. Preparation of finish subgrade to receive asphaltic concrete paving;
 - 4. Necessary accessories;
 - 5. Aggregate base;
 - 6. Asphaltic concrete paving;
 - 7. Sealing of asphaltic concrete paving;
 - 8. Submittal preparation;
 - 9. Clean up.
- B. Related Sections:
 - 1. Section 31 20 00: Earthwork
 - 2. Section 31 31 19: Vegetation Control
 - 3. Section 32 17 00: Paving Accessories and Striping

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Submit copies of material product data and asphaltic concrete mix design for review by the Architect prior to beginning work.

1.03 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Mixing plant shall conform to the standards set by the State of California Department of Transportation.
 - 2. Work shall be performed in conformance with the Standard Specifications of the State of California Department of Transportation.
- B. Environmental Requirements:
 - 1. Do not apply tack and/or prime coats over wet surfaces.
 - 2. Installation of asphaltic concrete shall not take place when the temperature is below 50 degrees F.
- C. Warranty:
 - 1. Contractor shall repair any portions of asphaltic paving that exhibit signs of creeping, cracking, shoving, raveling, softening, or other defects within one year of the acceptance of the project.

**ASPHALTIC CONCRETE PAVING
SECTION 32 12 16**

PART 2 PRODUCTS

2.01 MATERIALS

- A. Soil sterilant shall be per Section 31 31 19 "Vegetation Control".
- B. Aggregate base shall comply with CalTrans Standard Specifications, Section 26 for Class II base.
- C. Tack coat shall be emulsified asphalt conforming to AASHTO M208 ASTM D2397 CSS-1 or CSS-1h.
- D. Dilute one-part water to one-part emulsified asphalt.
- E. Asphaltic concrete shall be hot-mix type B asphaltic concrete, uniformly graded aggregate to 1/2" maximum, medium grading, per State of California CalTrans Standard Specifications, Section 39, using PG 64-10 profile-graded asphalt. No Recycled Asphalt Pavement (RAP) will be allowed in aggregate.
- F. Fog Seal:
 - 1. Topein-C, a water-based dispersion of a homogeneous mixture of tall oil pitch, asphaltine resin, and petroleum asphalt, as manufactured by Alon Asphalt-Bakersfield.
- G. Joint Sealant:
 - 1. Use Novalink SL Self-leveling Joint Sealant.
 - 2. Or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Commencement of work indicates acceptance of surface conditions.
- B. Verify subgrade compaction prior to placing Aggregate Base.

3.02 SEQUENCE AND SCHEDULING

- A. For projects involving a construction manager, the contractor shall plan on at least 2 mobilizations to site project areas. The locations and scheduling shall be as determined by the construction manager at a later date.

3.03 INSTALLATION OR APPLICATION

- A. Installation shall be performed in conformance with CalTrans Standard Specifications, unless noted otherwise.

**ASPHALTIC CONCRETE PAVING
SECTION 32 12 16**

- B. Edges of paving not confined by concrete structures shall be confined by the use of header boards.
- C. Compact subgrade to required compaction indicated in Section 31 20 00. "Earthwork", and as shown on construction plans.
- D. Aggregate base shall be placed over compacted subgrade and compacted to 95% of the maximum density per ASTM D-1557 per Section 26 of the CalTrans Standard Specifications.
- E. Apply soil sterilant on the compacted aggregate base per the manufacturer's recommendations immediately prior to paving.
- F. Apply tack coat to vertical surfaces joining new AC paving at a rate of 0.10 gallon per square yard. Do not place tack coat on surfaces to remain exposed.
 - 1. Allow sufficient time for proper curing of tack coat prior to installing AC paving.
- G. Install AC paving in number of layers required in Section 39-6 of the CalTrans Standard Specifications.
- H. Spread AC paving and perform first coverage of initial or breakdown compaction when paving mixture is not less than 250 degrees F. All breakdown compaction shall be completed before the temperature of the mixture drops below 200 degrees F.
- I. Construct AC paving to required thickness and provide flush transitions to adjacent headers, walks, etc. Where paving will drain onto adjacent concrete surfaces, paving shall be set 1/8" to 1/4" higher than concrete surface (i.e. gutters).
- J. Per CalTrans Section 39-6: "Segregation of aggregate shall be avoided, and the surfacing shall be free from pockets of coarse or fine material. Asphalt concrete or asphalt concrete base containing hardened lumps shall not be used." Saw cut, remove, and replace areas of asphalt paving with visible segregated aggregate.
- K. Roll paving to obtain maximum compaction.
- L. Inspect surface and repair surface prior to final rolling.
 - 1. Fill voids in surface.
 - 2. Remove roller marks.
- M. Install fog seal per manufacturer's recommendations.

**ASPHALTIC CONCRETE PAVING
SECTION 32 12 16**

3.04 INSTALLATION OR APPLICATION

- A. Do not permit vehicular traffic on paving until it has cooled and hardened.
 - 1. Provide barricades as required.
- B. Once accessories, site signage, or athletic and playfield equipment have been installed, patch joint between concrete and AC paving, as well as over-cutting of paving with specified joint sealant.
- C. Protect existing property and the work of other trades.

3.05 INSTALLATION OR APPLICATION

- A. Tolerances:
 - 1. Completed asphalt base course shall not vary in thickness more than 1/4" from design thickness.
 - 2. Completed asphalt surface course shall not vary in thickness more than 1/4" from design thickness.
 - 3. Completed asphalt base course surface plane elevation shall not deviate more than 1/4" when measured in relation to a 10'-0" straightedge laid in any direction.
 - 4. Completed asphalt surface course plane elevation shall not deviate more than 1/4" when measured in relation to a 10'-0" straightedge laid in any direction. Surface elevation shall not deviate more than 1/4" from design elevations.
 - 5. Flood test finished paved surfaces in the presence of the architect.
 - 6. Areas of residual ponding water exceeding 1/4" in depth shall be corrected to the satisfaction of the Architect.

END OF SECTION

**SITE CONCRETE PAVING
SECTION 32 13 00**

PART 1 GENERAL

1.01 SUMMARY

A. Inclusions:

1. Provisions set forth in Divisions 0 and 1;
2. Concrete flatwork other than buildings and structures;
 - a. Including concrete walks, drive approaches, curbs, gutters, ramps, steps, risers, mow strips, etc. equipment;
3. Concrete recesses pits for truncated dome tilework
4. Curing, protection, and patching of site concrete;
5. Vegetation control;
6. Expansion and tool joints in site concrete;
7. Caulking of expansion joints in site concrete;
8. Accessories and associated hardware;
9. Installation of cast-in-place truncated dome tiles;
10. Forming and shoring for site concrete;
11. Placing of sleeves, inserts, and embedded items in site concrete;
12. Clean sand fill under concrete flatwork or slabs as required for leveling and/or final grading of base;
13. Submittal preparation;
19. Clean up.

B. Related Sections:

1. Section 31 00 00:	Earthwork
2. Section 31 31 19:	Vegetation Control
3. Section 03 20 00:	Reinforcing Steel
4. Section 05 41 00:	Structural Metal Stud Framing
5. Section 10 14 56:	Site Signage
6. Division 23 00 00:	Mechanical
7. Division 26 00 00:	Electrical

1.02 SUBMITTALS

A. Product or Material Data:

1. Submit copies of the concrete mix design to the Architect for review prior to installing materials.
2. Submit copies of the product data to the Architect for review prior to installing the following:
 - a. Expansion joints.
 - b. Joint caulking material.

C. Shop Drawings or Layout Drawings:

1. Submit copies of shop drawings to the Architect for review prior to beginning fabrication.

**SITE CONCRETE PAVING
SECTION 32 13 00**

1.03 QUALITY ASSURANCE

A. Regulatory Compliance:

1. Walks and sidewalks shall have a continuous common surface, not interrupted by steps or by abrupt changes in level exceeding 1/2 inch, and shall be a minimum of 48 inches in width. Surfaces shall be slip-resistant as follows:
 - a. Slopes less than 5 percent:
 - 1) Surfaces with a slope of less than 5%- gradient shall be at least as slip-resistant as that described as a medium broom finish. (Refer to CBC 11B-302)
 - b. Slopes 5% percent or greater:
 - 1) Surfaces with a slope of 5 percent or greater gradient shall be at least as slip-resistant as that described as a heavy broom finish. (Refer to CBC 11B-302)
 - 2) Aluminum Oxide Aggregate surface-applied finish

B. Testing:

1. Prior to preparation of finish sub-grade for work of this Section, the contractor shall give appropriate notification to the inspector and allow adequate time for compaction tests to be taken when required by the inspector prior to work to sub-grade.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement:

1. Conform to ASTM C150, Type II or V, with the following exceptions:
 - a. Cement shall not contain more than 0.60% total alkali when calculated as Sodium Oxide.

B. Fly Ash:

1. Conform to ASTM C618, Class F
 - a. Fly Ash may substitute cement for up to 15% of mix C+P content provided that the design mix meets 28 day strength requirements.

C. Aggregates:

1. Conform to ASTM C33.
2. Fine aggregate shall consist of washed natural sand.
 - a. Fine aggregate shall not contain more than two percent (2%) by weight of deleterious substances.
 - b. Fine aggregate shall meet the requirements of Table 1 below.
3. Coarse Aggregate shall consist of a clean, crushed rock or washed gravel.
 - a. Shall not contain more than five percent (5%) by weight of flat, thin, elongated, or laminated material.
 - b. Shall not contain more than two percent (2%) by weight shale or cherty material.

**SITE CONCRETE PAVING
SECTION 32 13 00**

- c. Coarse aggregate shall be 3/4" maximum size, see requirements of Table 1 below.
- D. Water shall be potable, clean and free from organic materials.
 - 1. Table 1 - GRADING OF COMBINED AGGREGATES
 - a. Sieve (Woven Wire Cloth): Passing a 1-1/2"
 - 1) Percent by Weight 3/4" Maximum
 - b. Sieve (Woven Wire Cloth): Passing a 1"
 - 1) Percent by Weight 3/4" Maximum
 - c. Sieve (Woven Wire Cloth): Passing a 3/4"
 - 1) Percent by Weight 3/4" Maximum: 90-100
 - d. Sieve (Woven Wire Cloth): Passing a 3/8"
 - 1) Percent by Weight 3/4" Maximum: 55-75
 - e. Sieve (Woven Wire Cloth): Passing a #4
 - 1) Percent by Weight 3/4" Maximum: 40-60
 - f. Sieve (Woven Wire Cloth): Passing a #8
 - 1) Percent by Weight 3/4" Maximum: 30-46
 - g. Sieve (Woven Wire Cloth): Passing a #16
 - 1) Percent by Weight 3/4" Maximum: 23-40
 - h. Sieve (Woven Wire Cloth): Passing a #30
 - 1) Percent by Weight 3/4" Maximum: 13-28
 - i. Sieve (Woven Wire Cloth): Passing a #50
 - 1) Percent by Weight 3/4" Maximum: 5-15
 - j. Sieve (Woven Wire Cloth): Passing a #100
 - 1) Percent by Weight 3/4" Maximum: 0-5
 - Note: "Pea Gravel" mixes (mixes with 3/8" max. aggregate size), other than mixes used for exposed aggregate finish, will not be allowed.

2.02 ACCESSORIES

- A. Concrete Expansion Joints:
 - 1. Expansion joints shall be formed with 3/8" x 3-1/2" expansion joint and 3/8" x 1/2" expansion joint cap.
 - a. Quality Standard:
 - 1) Sealtight by W. R. Meadows:
 - (a) Fibre Expansion Joint.
 - (b) Snap-Cap Expansion Joint Cap.
 - 2) Expansion joint sealant shall be self-leveling polyurethane sealant for horizontal expansion joints.
 - (a) Conform to ASTM C 920, Type M, Grade P, Class 25, and Fed Spec. TT-S-00227E, Type I, Class A:
 - (1) W.R. Meadows, Sealtight Pourthane SL
 - (2) BASF Masterseal SL2;
 - (3) Or equal.
- B. Clean sand fill under concrete flatwork or slabs shall conform to the fine aggregate specification above.

**SITE CONCRETE PAVING
SECTION 32 13 00**

- C. Curing Compound shall white-pigmented.
 - 1. Conform to ASTM C309.
- D. Slip-Resistive Aggregate:
 - 1. Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide, unaffected by freezing, moisture, and cleaning materials.
 - a. Design Standard: EMAC-20 by Lambert Corp.
- E. Sealer hardener shall be clear, non-yellowing, sealer-hardener.
 - 1. Install per manufacturer's recommendations.
 - a. BASF Kure-N-Harden water-based silicate sealer or equal.
- F. Retarder shall be specifically designed to retard the hydration in cement only for a depth required to expose the aggregate.
 - 1. Quality Standard:
 - a. The Euclid Chemical Company-Formula S.
- G. Tactile Warning Devices:
 - 1. Shall be in conformance with CBC Section 11B-705.
 - a. Cast-in-Place vitrified polymer composite, Armor-Tile manufactured by Engineered Plastics, Inc.
 - b. Submit a written five (5) year product warranty provided by the manufacturer of detectable warning products and directional surfaces. Such warranty shall indicate compliance with architectural standards as published in the current edition of the California Building Standards Code, and also include durability criteria which indicate that the shape, color fastness, confirmation, sound-on-cane acoustic quality, resilience, and attachment will not degrade significantly for at least five (5) years after initial installation. "Not degrade significantly" means that the product maintains at least 90 percent of its approved design characteristics, as determined by the enforcing agency.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Start of work shall be considered as acceptance of existing conditions.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. A weighmasters certificate shall accompany each load of concrete.
 - 1. This certificate is to be delivered to the Project Inspector and Project Manager.
- B. Cement shall be stored in such a manner so as to protect it from damage.
- C. Only one (1) brand of cement shall be used for this work.

**SITE CONCRETE PAVING
SECTION 32 13 00**

3.03 SEQUENCING AND SCHEDULING

- A. Concrete shall be poured within 90 minutes of mixing.

3.04 VEGETATION CONTROL

- A. Immediately prior to installing concrete, vegetation control chemicals shall be applied to the soil.

3.05 INSTALLATION OR APPLICATION

- A. Install per the manufacturer's latest written recommendations.
- B. Concrete shall conform to the recommendations of the Portland Cement Association and the American Concrete Institute, unless otherwise shown or noted in these specifications.
- C. Preparation and Compaction:
 - 1. Concrete flatwork or vehicle traffic areas shall be placed over rolled sub-grade.
 - a. Proof roll sub-grade and rework unsuitable areas prior to installing leveling sand fill.
 - b. Compact subgrade to 95% relative compaction in traffic areas.
 - c. Compact subgrade to 90% relative compaction in pedestrian walks and other slab areas.
- D. Forms:
 - 1. Forms shall be built true-to-line and grade.
 - 2. Forms shall be rigid enough to prevent excessive deflection between supports.
 - a. Supporting studs or joists shall not be spaced more than twelve inches on center.
 - 3. The site curbs and gutters shall conform to the CalTrans specifications. The surfaces are to be true and straight. The maximum tolerance for the top, edges or any face is 0.01' (1/8") from the edge of a ten foot straight-edge.
 - 4. The curved site curbs and gutters shall conform to the CalTrans specifications. The surfaces are to be true and uniform using flexible formboards. The maximum tolerance for the top, edges or any face is 0.01' (1/8") from the edge of a ten foot straight-edge.
 - 5. Arrangement and construction shall be subject to the approval of the Architect.
 - a. Responsibility for adequacy of the forms rests with the Contractor.
 - 6. Coordinate to properly receive other construction, accessories, and anchorage.
 - a. Install sleeves, inserts, bolts, conduit, or other devices prior to placing concrete.
 - b. Install waterstops at all vertical expansion joints and construction joints.

**SITE CONCRETE PAVING
SECTION 32 13 00**

- E. Forms for Exposed Vertical Concrete:
1. Exposed concrete shall be formed with Douglas Fir "Plyform" placed with the grain of the outer plies in the direction of their span.
 - a. The surfaces of the forms shall be smooth and free from irregularities.
 - b. Wall-form panels shall be placed with their long dimension horizontal.
 2. All exposed sharp corners shall be formed with 3/4" chamfers or fillets.
- F. Form ties or bolts shall be used to fasten the forms.
1. Use sufficient strength and number to prevent spreading of forms.
 - a. Wire ties will not be permitted.
 2. Ties shall be of such type that they can be entirely removed or cut back one inch (1") or more from the finished concrete surface.
- G. Form Coating:
1. Forms shall be coated with non-staining form oil.
 - a. Apply shortly before the concrete is placed, prior to placing the reinforcement.
- H. Form Removal:
1. Form removal shall be performed in such a manner as to prevent damage to the concrete.
 2. Do not remove forms until the concrete has sufficiently hardened to permit their removal with safety.
 - a. Form removal will not be allowed in less time than as follows:

<u>Type of Work</u>	<u>Minimum Time</u>
Walls, Vertical Forms	24 hours
Slabs	24 hours

Note: Time is measured from addition of cement to aggregate.

- I. Embedded Items:
1. Cooperate with all trades to insure that all conduit, anchor bolts, sleeves, inserts, hangers, trench drains, grates, etc., are properly installed and secured in correct position.
 - a. Embedded items shall be thoroughly clean and free from rust, scale, oil, or other foreign matter.
 - b. All embedded items shall be securely held in their final positions by means of templates before concrete is poured.
 - c. All pipes and conduits penetrating slabs shall be sleeved with PVC pipe, sized 1/2" larger I.D. vs pipe O.D. (1/4" gap around), and topped with self-leveling sealant.
- K. Reinforcement:
1. Concrete walks under roof areas shall be reinforced with #3 bars at 24" on center each way minimum, unless noted otherwise.
 - a. Provide #4 bar dowels at 24" O.C. into adjacent footings.

**SITE CONCRETE PAVING
SECTION 32 13 00**

2. Locate reinforcement at mid height of flatwork or slab.

L. Mixing:

1. Transit-Mixed Concrete:
 - a. Mix and deliver in accordance with the requirements of ASTM C-94.
 - b. Weighmasters Certificate shall accommodate each load of concrete.
 - c. Water/(cement+fly ash) ratio shall be 0.50 or less.
2. Slump:
 - a. The amount of mixing water used shall not cause the slump to exceed the maximum allowed slump of 4 1/2".
 - b. Slump test shall conform to ASTM C-143.

M. Placing:

1. Concrete shall be used while fresh and before it has taken an initial set.
 - a. Retempering partially hardened concrete will not be permitted.
2. Place concrete in horizontal layers of such thickness that can be satisfactorily consolidated with vibrators.
3. Place concrete as close as possible to its final position.
 - a. Use of vibrators for extensive shifting shall not be permitted.
4. Fresh concrete shall not be permitted to fall more than six feet (6'-0").
5. Maximum spacing of deep-tooled joints for site work shall be as follows:
 - a. 6 feet on center for sidewalks.
 - b. 24 feet on center for curbs and gutters
 - c. 12 feet on center for mow strips.
 - d. Mow strips for chain link fencing shall have deep tool joints at each post.
6. Deep tool joints shall be a minimum of 1 1/8" deep with 3/8" radii edging.
7. Tool edges of flatwork or slabs at construction joints and other exposed corners.
8. Tool and expansion joints shall be located where shown on plans. Align joints of curbs or curbs and gutters with adjacent sidewalks.
 - a. Tool joints shall be uniform, straight, made perpendicular to building face, and parallel to each other for a uniform and consistent look.
9. Expansion joints shall be placed at a maximum of 24 feet on center for sidewalks, curbs, and curbs and gutters.
 - a. Place expansion joints to align with the corners of buildings or structures and to align with the center of structural columns.

N. Cold Weather Requirements:

1. Do not place concrete on frozen ground.
2. Do not mix or place when atmospheric temperature is below 35 degrees F.
3. Protect concrete from freezing or frost for a period of five (5) days after placing.
4. Calcium Chloride shall not be added to the mix.

O. Curing:

1. Keep newly placed concrete moist for the first seven (7) days after the concrete has been placed, or;

SITE CONCRETE PAVING SECTION 32 13 00

2. Horizontal Surfaces:
 - a. Slabs poured in hot or dry weather shall have a fog spray applied to them during troweling.
 - b. Slabs shall be cured with curing compound.
 - 1) Spray-applied curing compound having white pigment.
 - (a) Conform to ASTM C-309.
 - (b) Fully coat surface to a solid white color.
 3. Vertical Surfaces:
 - a. If forms are removed prior to end of curing period, vertical surfaces shall be cured by one of the following methods:
 - 1) Plastic film with joints sealed or taped;
 - (a) The perimeter of the film shall be sprinkled once daily.
 - (b) Install as soon as form work is removed.
 - 2) Curing Compound
 - (a) Spray-applied curing compound having white pigment.
 - (1) Conform to ASTM C-309.
 - (2) Fully coat surface to a solid white color.
- P. Slip-Resistive Aluminum Oxide Aggregate Finish:
1. Before final floating, apply slip-resistive aggregate where indicated and to concrete ramps, landings, and stair treads.
 - a. Slip-Resistive Aluminum Oxide Granules Finish:
 - 1) As soon as surface water has disappeared, make one pass with the steel trowel and broadcast aluminum oxide onto the surface of concrete ramps, landings, and stair treads where indicated.
 - (a) Uniformly spread 1/4 pound of slip-resistive granules per square foot of surface (25#/100 sq.ft.). Lightly tamp aggregate flush with surface using a steel trowel, do not force below surface. After broadcasting and tamping, apply light float finish.
 - (b) After curing, wash surface with a 10% solution of muriatic acid and flush with fresh water to expose slip-resistive aggregate.
- R. Tactile Warning Tiles:
1. Install per manufacturer's recommendations:
 - a. **View complete installation training videos prior to work.**
 - b. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to placement of tiles.
 - c. Tiles shall be tamped or vibrated into the fresh concrete to insure the tile is flush to the adjacent concrete surfaces and that no air pockets or voids are present under the tiles.

3.06 QUALITY CONTROL

- A. Tolerances:
1. Concrete flatwork shall be true-to-plane to within 1/4" in 10'-0".

**SITE CONCRETE PAVING
SECTION 32 13 00**

- B. Field Testing:
 - 1. Any concrete in question to its quality may be tested at the discretion of the Architect, Inspector, or Owner. The Inspector may take concrete test cylinders from each batch of concrete.

3.07 PROTECTION OR ADJUSTMENTS

- A. Defective Concrete:
 - 1. Concrete will be considered defective for the following reasons:
 - a. Not meeting the minimum strength requirement.
 - b. Not formed as indicated.
 - c. Not true to intended alignment.
 - d. Containing voids or rock pockets.
 - e. Surface deviation of greater than specified tolerance.
 - f. Concrete damaged due to erection operations.
 - g. Concrete that does not fully conform to the specifications.
 - h. Inconsistent surface finishes.
 - 2. Defective concrete shall be removed and replaced with concrete complying with the drawings and specifications.
 - a. Unless otherwise approved by the Architect.

3.08 SCHEDULES

- A. TYPICAL CONCRETE FINISH SCHEDULE
 - 1. Type of Finish: slip-resistive aggregate finish
 - a. Type of Surface: concrete ramps and landings
 - 2. Type of Finish: heavy broom finish
 - a. Type of Surface: concrete slopes exceeding 6%
 - 3. Type of Finish: medium broom finish
 - a. Type of Surface: all other areas
- B. CONCRETE TEST-STRENGTH SCHEDULE
 - 1. Type: un-reinforced, reinforced and exposed aggregate finished concrete
 - a. Required Strength: 3000 psi
 - b. Minimum 7 Day Test: 1800 psi
 - c. Minimum 28 Day Test: 3000 psi

3.09 CLEANING OR REPAIR

- A. Formwork Cleaning:
 - 1. Remove dirt, chips, sawdust, nails, and other foreign matter from the forms before concrete is placed.
 - 2. Previously used forms shall be thoroughly cleaned of all dirt, mortar, and other foreign matter before reusing.
- B. Upon completion of other work, clean exterior finished concrete surfaces.
- C. Areas shall be swept and cleaned.

**SITE CONCRETE PAVING
SECTION 32 13 00**

- D. Remove from the premises surplus material, equipment and debris that result from this work.

END OF SECTION

**PAVING ACCESSORIES AND STRIPING
SECTION 32 17 00**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Concrete wheel stops;
 - 3. Road and Parking Barriers;
 - 4. Traffic striping and markings;
 - 5. Curb painting and markings;
 - 6. Accessories and associated hardware;
 - 7. Submittal preparation;
 - 8. Clean up.
- B. Related Sections:
 - 1. Section 09 91 13: Exterior Painting
 - 2. Section 32 12 16: Asphaltic Concrete Paving
 - 3. Section 32 32 13: Site Concrete

1.02 SUBMITTALS

- A. Product or Material Data:
 - 1. Submit copies of product data sheets.
 - 2. Submit copies of agency product to be incorporated into the work.
- B. Samples or Mockups:
 - 1. Submit one (1) sample of the manufacturer's complete color range to the Architect for color selection purposes prior to ordering material.

1.03 QUALITY ASSURANCE

- A. Regulatory Compliance:
 - 1. Maintain material safety data sheets for materials used.
 - 2. File onsite in a central location.
 - 3. Comply with the requirements of local agencies having jurisdiction over matter dealing with air quality.
- B. Qualifications:
 - 1. Work shall be performed only by individuals with specific knowledge and experience in this type of work.

**PAVING ACCESSORIES AND STRIPING
SECTION 32 17 00**

C. Warranty:

1. Warranty materials and application for one (1) year.
2. Defects or areas of excessive wear that appear within one year shall be repaired or reworked by contractor at no additional cost.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Concrete Wheel Stops:

1. Bakersfield Precast;
2. Or approved equal.

B. Traffic Paint:

1. Sherwin Williams;
2. Or approved equal.

2.02 MATERIALS

- A. Concrete wheel stops shall have a minimum compressive strength of 4000 psi and a minimum of two (2) #3 reinforcing bars in each unit for general automobile spaces. For truck and heavy vehicle stops, the stops shall be larger, 7" high x 12" wide x 6'-0" long, especially suited for larger vehicles and contain 4 #4 bars.

1. Bars shall be full length of unit less 2" for cover.
2. Cure for a minimum of 28 days prior to installation.

- B. Traffic line and court marking paint shall be Sherwin Williams, Setfast Acrylic Latex or Latex (TM series) Traffic Marking Paints as follows:

1. TM2160 WHITE
2. TM2161 LEAD FREE YELLOW
3. TM2132 RED
4. TM2133 BLUE - Meeting Fed. Spec. Color #15090, Fed. Std. 595B
5. TM2135 BLACK

(Architect- choose if D below is needed adjust C above if required)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify layout prior to beginning work.
- B. Start of work shall be considered as acceptance of existing conditions.

**PAVING ACCESSORIES AND STRIPING
SECTION 32 17 00**

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be transported, handled, and stored in conformance with the manufacturer's recommendations.
- B. Materials shall be delivered and stored in their original, unopened containers until they are incorporated into the work.

3.03 SEQUENCING AND SCHEDULING

- A. When applicable, coordinate work with the schedule established by the Construction Manager or Contractor.

3.04 INSTALLATION OR APPLICATION

- A. Wheel Stops (Parking Bumpers):
 - 1. Install at proper angles and in proper locations to prevent over-travel of vehicles.
 - 2. Embed wheel stops to pavement on a layer of mastic.
 - 3. Fix wheel stops into position with two (2) 1/2" rods driven a minimum of 24" into paving and base.
- B. Traffic Lines and Court Markings:
 - 1. Install per the manufacturer's latest written recommendations.
 - 2. Apply traffic paint to clean dry surfaces.
 - 3. Apply paint at the manufacturer's recommended rate of application.
 - 4. Use mechanical equipment to apply paint in straight uniform lineage.

Pavement Markings:

- 1. Painted lines shall be a minimum of 4" wide.
- 2. Crosswalk and limit lines shall be a minimum of 12" wide unless noted otherwise
- 3. Parking spaces for the Disabled shall be marked according to CBC Sections 11B-208 and 11B-502. Paint perimeter lines of the loading zone blue with white diagonal lines. Paint the 12" high "NO PARKING" letters white on a blue background.

- C. Accessible Parking Spaces:
 - 1. Paint the wheel stops blue.

3.05 PROTECTION OR ADJUSTMENTS

- A. Protect work until final acceptance.
- B. Remove wheel stops that have been damaged and replace with new.
- C. Patching of concrete stops will not be permitted.

**PAVING ACCESSORIES AND STRIPING
SECTION 32 17 00**

D. Repaint damaged or faded lines and markings.

3.06 CONDITION OF FINISHED WORK

A. Completed installation shall comply with approved plans.

B. Lines shall be straight, true, and uniform.

C. Over-spray shall not be permitted.

3.07 SCHEDULES

A. Line Color Schedule:

1. Parking stripes:	White
2. Accessibility markings:	Blue

END OF SECTION

**TACTILE WARNING SURFACING
SECTION 32 17 26**

PART 1 GENERAL

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Furnishing and installing cast-in-place tactile tile modules where indicated.
 - 3. Shop drawing and submittals;
 - 4. Clean-up.
- B. Related Documents:
 - 1. Section 32 13 13: Site Concrete Paving

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures, and routine maintenance.
- B. Samples for Verification Purposes: Submit two (2) tile samples minimum 6" x 8" of the kind proposed for use.
- C. Shop drawings are required for products specified showing fabrication details; composite structural system; plans of tile placement, including joints and material to be used, as well as outlining installation materials and procedures.
- D. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated. All test reports shall be conducted on a cast-in-place tactile tile system as certified by a qualified independent testing laboratory.
- E. Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of tactile tile and accessory as required.

1.03 QUALITY ASSURANCE

- A. Provide cast-in-place tactile tiles and accessories as produced by a single manufacturer.
- B. Installer's Qualifications: Engage an experienced installer certified in writing by tactile manufacturer as qualified for installation, who has successfully completed tile installation similar in material, design, and extent to that indicated for Project.

TACTILE WARNING SURFACING SECTION 32 17 26

- C. Americans with Disabilities Act (ADA): Provide tactile warning surfaces which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).
- D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR). Title 24, Part 1, Articles 2, 3, and 4 and Part 2, Section 205 definition of "Detectable Warning," Section 1127B.5 for "Curb Ramps," and Section 1133B.8.5 for "Detectable Warnings at Hazardous Vehicle Areas."
- E. Vitrified Polymer Composite (VPC) Cast-in-Place Tiles embedded in concrete shall meet or exceed the following test criteria:
 - 1. Accelerated Aging and Freeze Thaw Test of Tile when tested to ASTM D1037 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles, or other defects.
 - 2. Salt and Spray Performance of Tile and Adhesive System when tested to ASTM B117 not to show any deterioration or other defects after 100 hours of exposure.
 - 3. 2022 California Building Code, Chapter 11B.

1.04 SITE CONDITIONS

- A. Environmental Condition and Protection: maintain minimum temperature of 40 degrees F in spaces to receive tactile tiles for at least 48 hours prior to installations, during installation, and for not less than 48 hours after installation. Store tactile tile material in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 40 degrees F in areas where work is completed.
- B. The use of water for work cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the passengers or public. Provide barricades or screens to protect passengers or public.
- C. Disposal of any liquids or other materials of possible contamination shall be made in accordance with federal, state, and local laws and ordinances.
- D. Cleaning material shall have code-acceptable low VOC solvent content and low flammability if used on the site.

**TACTILE WARNING SURFACING
SECTION 32 17 26**

1.05 EXTRA STOCK

- A. Deliver extra stock to storage area designated by engineer. Furnish new materials from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identification for cast-in-place tactile tiles. Furnish not less than two (2) percent of the supplied materials for each type, color, and pattern installed.

1.06 GUARANTEE

- A. Cast-in-place tactile tiles shall be guaranteed in writing for a period of five years from date of final completion. The guarantee includes defective work, breakage, deformation, and loosening of tiles.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work, include, but are not limited to, the following:
 - 1. The Vitrified Polymer Composite (VPC) Cast-in-Place Tactile Tile specified is based on Armor-Tile manufactured by Engineered Plastics, Inc. (800-682-2525). Existing engineered and field-tested products which are subject to compliance with requirements, may be incorporated in the work and shall meet or exceed the specified test criteria and characteristics.

2.02 MATERIALS

- A. Vitrified Polymer Composite (VPC) cast-in-place tiles shall be an epoxy polymer composition with ultraviolet stabilized coating employing aluminum oxide particles in the truncated domes 0.2" in height, 0.9" diameter at the base, and 0.4" diameter at top of dome, spaced 2.35" nominal as measured on a diagonal, and 1.70" nominal as measured side by side. For wheelchair safety, the field area shall consist of a non-slip surface with a minimum of 40 - 90 degree raised points 0.045" high per square inch; "Armor-Tile" as manufactured by Engineered Plastics, Inc., Tel: 800-682-2525, or approved equal.
 - 1. Dimensions: Tiles shall be held within the following dimensions and tolerances:
 - a. Length and Width: 12" x 12"
 - 1) Depth: 1.400" +/- 5% max.
 - 2) Face Thickness: 0.1875 +/- 5% max.
 - 3) Warpage of Edge: +/- 0.5% max.

TACTILE WARNING SURFACING

SECTION 32 17 26

- b. Length and Width: 36" x 48"
 - 1) Depth: 1.400" +/- 5% max.
 - 2) Face Thickness: 0.1875 +/- 5% max.
 - 3) Warpage of Edge: +/- 0.5% max.
2. Water absorption of tile when tested by ASTM D570 not to exceed 0.35%.
3. Slip resistance of tile when tested by ASTM C1028 the combined wet/dry static co-efficient of friction not to be less than 0.80 on top of domes and field area.
4. Compressive strength of tile when tested by ASTM D695-91 not to be less than 18,000 psi.
5. Tensile strength of tile when tested by ASTM D638-91 not to be less than 10,000 psi.
6. Flexural strength of tile when tested by ASTM C293-94 not to be less than 24,000 psi.
7. Chemical stain resistance of tile when tested by ASTM D543-87 to withstand without discoloration or staining - 1% hydrochloric acid, urine, calcium chloride, stamp pad ink, gum, and red aerosol paint.
8. Abrasive wear of tile when tested by BYK - Gardner Tester ASTM D 2486* with reciprocating linear motion of 37 +/- cycles per minute over a 10" travel. The abrasive combined mass of the sled, weight, and wood block to be 3.2 lb. Average wear depth shall not exceed 0.030 after 1000 abrasion cycles measured on the top surface of the dome representing the average of three measurement locations per sample.
9. Fire resistance: when tested to ASTM E84 flame spread be less than 25.
10. Gardner impact to geometry "GE" of the standard when tested by ASTM D5420-93 to have a mean failure energy expressed as a function of specimen thickness of not less than 450 in. lbf./in. A failure is noted if a hairline fracture is visible in the specimen.
11. Accelerated weathering of tile when tested by ASTM G26-95 for 2000 hours shall exhibit the following result - no deterioration, fading, or chalking of surface of tile.
12. Embedment flange spacing shall be 3.0" minimum to 3.1" maximum center-to-center spacing as illustrated on product drawing.
13. Color: Yellow conforming to Federal Color No. 33538. Color shall be homogenous throughout the tile. Tiles are also available in Light Grey, Dark Grey, Onyx Black, Pearl White and Brick Red.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrapping and tile type shall be identified by part number.

**TACTILE WARNING SURFACING
SECTION 32 17 26**

- B. Tiles shall be delivered to location at building site for storage prior to installation.

3.02 INSTALLATION

- A. During the installation procedures, ensure adequate safety guidelines are in place, and that they are in accordance with the applicable industry and government standards.
- B. The specifications of the structural adhesives, fasteners, and related materials shall be in strict accordance with the contract documents and the guidelines set by their respective manufacturers.
- C. The physical characteristics of the concrete shall be consistent with the contract specifications, while maintaining a slump range of 4-7 to permit solid placement of the Cast-in-Place Tile System. An overly wet mix will cause the Cast-in-Place System to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 lbs.) shall be placed on each tile.
- D. Prior to placement of the Cast-In-Place System, the contract drawings shall be reviewed.
- E. The concrete pouring and finishing operations require typical mason's tools, however, a 4' long level with electronic slope readout, 25 lb. weights, and a large non-marring rubber mallet are specific to the installation of the Cast-In-Place System. A vibrating mechanism, such as that manufactured by Vibco, can be employed, if desired. The vibrating unit should be fixed to a soft base, such as wood, at least 1 foot square.
- F. The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.
- G. When preparing to set the tile, it is important that NO concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes around the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each vane on the underside of the tile. This will lock the tile solidly into the cured concrete.

TACTILE WARNING SURFACING

SECTION 32 17 26

- H. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawing. The cast-in-place tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
- I. Immediately after tile placement, the tile elevation is to be checked to adjacent concrete. The tile elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design indicates.
- J. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to float the concrete around the tile's perimeter, flush to the field level of tile.
- K. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning, or external forces placed on the tile to rock the tile, causing a void between the underside of tile and concrete.
- L. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 lbs. each shall be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
- M. Following the curing of the concrete, protective plastic wrap is to be removed from the tile face by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft wire brush will clean the residue without damage to the tile surface.
- N. If desired, individual tiles can be bolted together using 1/4 inch or equivalent hardware. This can help to ensure that adjacent tiles are flush to each other during the installation process. Tape or caulking can be placed on the underside of the bolted butt joint to ensure that concrete does not ooze up between the tiles during installation. Any protective plastic wrap, which was peeled back to facilitate bolting or cutting, should be replaced and taped to ensure that the tile surface remains free of concrete during the installation process.
- O. Tiles can be cut to custom sizes, or to make a radius, using a continuous rim diamond blade in a circular saw or mini-grinder. Use of a straightedge to guide the cut is advisable where appropriate.

**TACTILE WARNING SURFACING
SECTION 32 17 26**

- P. Any sound-attenuating plates on the underside of the tile, which are dislodged during handling or cutting should be replaced and secured with construction adhesive. The air gap created between these plates and the bottom of the tile is important in preserving the detectability properties of the tile.

3.03 CLEANING AND PROTECTING

- A. Protect tiles against damage during construction period to comply with tactile tile manufacturer's specifications.
- B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- C. Clean tactile tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project.
Clean tactile tile by method specified by tactile tile manufacturer.

END OF SECTION

**IRRIGATION
SECTION 32 80 00**

DIVISION 00 AND 01 ARE A PART OF THIS SECTION

Part 1 - General

1.01 Description of Work

- A. All labor, materials, tools and the transportation and performance of all the work required as indicated on the Drawings and Specifications and reasonably incidental to:
 - 1. Connection to water supply at point of connection indicated on plans.
 - 2. Irrigation mains, laterals and couplings.
 - 3. Automatic controllers and wiring.
 - 4. Electric control valves.
 - 5. Sprinkler heads and swing joints.
 - 6. Fertigation unit assembly
 - 7. Valve boxes.
 - 8. All related trenching and backfilling.

1.02 Related Work

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

1.03 Quality Assurance

- A. Examine all sections of Specifications and Drawings for Work related to this Section.
- B. Install irrigation system in accordance with all applicable codes and regulations. Installer shall have had considerable experience and demonstrate ability in the installation of irrigation systems of specified type(s) in a neat, orderly, and responsible manner in accordance with recognized standards of workmanship.
- C. Contractor shall check static pressure at the irrigation point of connection to the water supply before beginning work and notify Landscape Architect in writing of the pressure available.
- D. Contractor shall notify the Landscape Architect and the Inspector 5 working days in advance when each work phase is ready to be inspected.
- E. Contractor shall provide "As-Built" plans for the irrigation system per the General Conditions and prior to final acceptance of work. In addition, (1) colored coded controller chart bond copy shall be reduced in size, laminated with vinyl film, and placed in the controller enclosure, and two full size photo mylar copies shall be provided to the District.
- F. The Contractor shall maintain continuous power and water supply to all facilities that are directly or indirectly affected by this construction, unless other arrangements are made with the District for temporary shut-offs.
- G. The Contractor shall protect the public health, safety and welfare during all phases of the work.
- H. Contractor's price shall include an amount to install five (5) additional sprinkler heads of each type and one (1) additional valve of each type and size from that quantity shown on the drawings at no additional cost to the

**IRRIGATION
SECTION 32 80 00**

District. Nozzle changes to accommodate existing conditions shall be provided at no additional cost to the District. All unused additional sprinklers shall be delivered to the District as spares prior to final payment.

- I. Crew Training for Solvent Weld PVC & Mechanical joint restraint Installation:
 - 1. The Contractor shall be required to provide crew members that will install PVC for mandatory training and certification. Contractor shall schedule training a minimum of 10 days prior to the installation of any pipe on the site.
- J. All meetings, including training, shall be conducted in English. The Contractor shall provide an interpreter, at the Contractors expense, to translate for his/her non-English or poor English speaking representative(s).

1.04 Guarantee

- A. Contractor shall provide a one (1) year guarantee from the filing date of the Notice of Completion and Final Acceptance of the Work. Any pipes, valves, heads, planting, and paving, which has settled shall be reinstalled to the proper level at no cost to the District. Completely restore all damaged planting, paving, or other improvements.

1.05 Instruction, Training and Support

- A. Provide instruction to the District 's maintenance personnel in the operation and maintenance of the system. All warranties, product data and manuals shall be bound together with 8 1/2" by 11" reduced site irrigation plans showing zones in 9" by 12" black 3 ring binders. Contractor is to provide for one year of on-site technical support and continuing training after the filing date of the Notice of Completion by the District at no additional cost to the District.

Part 2 - Products

2.01 Acceptable Manufacturers

- A. Rainbird Sprinkler Mfg.
- B. Hunter Industries
- C. Applied Engineering

2.02 Materials: All materials shall be as indicated on the plan, irrigation schedule and as specified herein.

- A. Piping and Fittings:
 - 1. Polyvinyl chloride pipe:
 - a. ASTM D2241, rigid, unplasticized PVC, extruded from virgin parent material. Provide pipe homogeneous through and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.
 - (1) Main line: CI 200 PVC.
 - (2) Lateral Lines: Schedule 40 PVC.
 - 2. PVC pipe fittings:
 - a. Fittings for Schedule 40 PVC shall be ASTM D2241 Schedule 40 PVC molded fittings suitable for solvent weld, slip joint Ring Tite seal or screwed connections. Fittings made of other materials are

**IRRIGATION
SECTION 32 80 00**

not permitted.

- (1) Sleeve main and lateral lines below walks and paving.
- (2) PVC schedule 40 fittings w/ glued joints shall be utilized. The glue manufacturer shall furnish training for landscape contractor. Staff personnel shall be certified and wear a photo ID after receiving training.
- (3) Size slip fitting socket taper to permit a dry unsoftened pipe end to be inserted no more than halfway into the socket. Saddle and cross fittings are not permitted.
- (4) Use male adapters for plastic to metal connections. Hand-tighten male adapters plus one turn with a strap wrench.

B. Controller Wires:

1. Shall be solid copper conductors, 600 volt AC, Type UF-AWG, UL approved for direct burial. Common wire to be # 12 AWG size; station wires to be # 14 AWG size, minimum.
2. Wires shall be placed adjacent to irrigation mains wherever practical within grey schedule 40 PVC conduit throughout the project.

C. Master Valve/Flow Sensor assembly: Contractor is to connect the unit to the irrigation controller as per manufacturer's recommendations.

D. Tracer Wire: All water pressure lines to be installed with #12 tracer wire except where control wires are located adjacent to pressure lines.

E. Utility Marker Tape: Any control wires that do not follow irrigation pipes shall be 24 inches deep and marked with continuous utility marking tape located 6 inches below finish grade.

F. Solvent: ASTM D2466 recommended by manufacturer of approved pipe.

G. Controllers – Rainbird LXME2 Pro with IQ communication cartridge as specified on plans.

1. Each controller shall be installed with a separate common wire. Common wires cannot be shared between controllers.
2. Locate controllers adjacent to provide power supply as indicated on plans.

H. Control Valves: Remote Control Valves.

1. Provide valves with pressure regulating feature for all tree bubbler and drip bubbler systems, unless insufficient pressure is available.
2. Provide identification tag attached to valves indicating valve/station number as shown on drawings. Rainbird valve tags model #VID1Y24
3. Locate valve boxes a maximum of 2' from curbs or hardscape.
4. Do not provide swing joints on control valves. At all irrigation valve installations, turn PVC tee from main line to valve 90 degrees so the tee faces to the side. Size to match valve size.
5. Schedule 80 TOE ("threaded one end") nipples are the only acceptable method of attaching threaded inlet/outlet valves to all irrigation piping and/or fittings. At no time shall SCH 40 male adapters be used on any threaded valves to main lines.

I. Heads

1. Install two deep root watering systems per tree.
2. Install one deep root watering system per shrub.

J. Valve boxes: Valve box shall be as specified on plans.

IRRIGATION
SECTION 32 80 00

2.03 Rain Sensor – Automatic Shut Off: Rain Guard Shut Off Device Model as specified on plans.

2.04 Valve Tags – Shall be by T. Christy Enterprises, standard size tags, which shall be irrigation yellow color with controller letter and valve numbers hot stamped in black (ie: A-1 for controller A – Valve #1). ID Tags shall be installed prior to the punch list review.

2.05 Trenches

- A. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 6" depth. Provide compaction of 95% over main lines where they cross under areas with concrete or AC paving. Compact all other trench backfill to 85%.
- B. Trench depth shall be minimum 18" deep for pressure lines. Lateral lines shall be a minimum of 12" deep. Under paving trench depth shall be a minimum of 24" deep. Maintain 12" of horizontal clearance between lines of other trades.

Part 3 – Execution

3.01 Inspection

- A. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.

3.02 Preparation

- A. Layout and stake the location of each pipe run and all sprinkler heads and sprinkler valves. Obtain Landscape Architect's acceptance of layout prior to excavating.
- B. Strip sod for pipe trenches with a mechanical sod stripper uniformly 1" to 1-1/2" thick with clean cut edges.
- C. Place sleeves as indicated for installation of piping and conduit for control wires.

3.03 Installation

- A. Excavating and backfilling:
 - 1. All excavation shall be considered unclassified excavation and include all materials encountered.
 - 2. Excavate trenches to depth and width indicated on drawings to permit proper handling and installation of pipe and fittings.
 - 3. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 6" depth.
 - 4. Provide compaction of 95% over main lines where they cross under areas with concrete or AC paving. Compact all other trench backfill to 90%.
 - 5. Replace stripped sod in sufficient time to allow for satisfactory sod recovery and growth. Water stripped and reinstalled sod until irrigation system is placed in operation.

IRRIGATION
SECTION 32 80 00

6. Replace paving of same materials, using joints and patterns to match existing adjoining paving surfaces.
- B. Plastic Pipe:
 1. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction.
 2. Saw cut plastic pipe. Use a square-in sawing vice, to insure a square cut. Remove burrs and shavings at cut ends prior to installation.
 3. Make plastic-to-plastic joints with solvent weld joints for slip seal joints. Use only solvent recommended by the pipe manufacturer. Install plastic pipe fittings in accordance with pipe manufacturer's instructions. Contractor shall make arrangements with pipe manufacturer for all necessary field assistance.
 4. Make plastic to metal joints with plastic male adapters.
 5. Make solvent weld joints in accordance with manufacturer's recommendations.
 6. Allow joints to set at least 24 hours before pressure is applied to the system.
 7. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods when pipe installation is not in progress.
- C. Sprinklers, fittings, valves, and accessories:
 1. Install fittings, valves, bubblers, risers and accessories in accordance with manufacturer's instructions, except as otherwise indicated.
 2. Set bubblers perpendicular to finished grade and 2 inches from pavement edge, except as otherwise indicated. Nozzle changes shall be made at no cost to the District.
 3. Obtain Landscape Architect's review and acceptance of height for proposed sprinkler heads and valves prior to installation.
 4. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distance indicated.
 5. Install controller(s) as detailed.
 6. Install in-ground control valves in a valve access box as indicated.
 7. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box.
 8. Seal threaded connection on pressure side of control valves with Teflon tape or approved plastic joint type compound.
- D. Control Wiring:
 1. Install control wire in the piping trenches wherever possible.
 - a. Place control and common wires within grey sch 40 conduit in trench adjacent to irrigation mainline pipe as per installation detail.
 - b. Install wire with slack to allow for thermal expansion and contraction.
 - c. Expansion joints in wire to be provided at 200-foot intervals by making 5-6 turns of the wire around a piece of 1/2" pipe instead of slack.
 - d. Where necessary to run wire in a separate trench, provide a minimum cover of 18" as detailed.
 2. Provide sufficient slack at site connections at remote control valve in control boxes and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.
 3. Connect each remote-control valve to one station of a controller except as otherwise indicated.

IRRIGATION

SECTION 32 80 00

4. Connect each remote-control valve to a common ground wire system independent of all other controllers.
 5. Make wire connection to remote control electric valves and splices of wire in the field, using wire connectors and sealing cement in accordance with manufacturer's recommendations.
 6. Provide tight joints to prevent leakage of water and corrosion build-up on the joint.
 7. Wire splices shall only be made in accessible valve boxes.
 8. Utilize sleeves for installation of the irrigation system where indicated on drawings.
 9. Provide new sleeves for all locations where existing sleeves are not indicated. Install new sleeve prior to paving installation wherever possible.
 10. Remove and replace existing concrete and asphalt surfaces where cutting is necessary. Obtain District's and Architect's permission before cutting existing concrete and asphalt.
- E. Flushing, testing, and adjustment:
1. After sprinkler piping and risers are installed and before sprinkler heads are installed, open control valves and flush out the system with full head of water.
 2. Perform system testing upon completion of each section. When main line installation has been completed, pressurize to 125 pounds for a period of 6 hours. Inspector and Landscape Architect shall observe test. Make necessary repair and re-test repaired sections as required.
 3. Adjust sprinklers after installation for proper and adequate distribution of the water over the coverage pattern. Adjust for the proper arc of coverage.
 4. Tighten nozzles on spray type sprinklers after installation. Adjust sprinkler adjusting screw on lateral line or circuit as required for proper radius. Interchange nozzles patterns as directed by the Landscape Architect, to give best arc of coverage.
 5. Adjust all electric remote control valve pressure regulators and flow control stems for system balance and optimum performance.
 6. Test and demonstrate the controller by operating appropriate day, hour, and station selection features as required of each season per Service section below.

3.04 Disposal of Waste Material

- A. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.
- B. Maintain disposal route clear, clean, and free of debris.

3.05 Acceptance

- A. Test and demonstrate to the Landscape Architect and District satisfactory operation of the system free of leaks.
- B. Instruct the District's designated personnel in the operation of the system, including adjustment of sprinklers, controller(s), valves, and flow sensing controls.
- C. Upon acceptance the District will assume operation of the system.
- D. All record documents must be approved and submitted prior to final payment per the General Conditions.

**IRRIGATION
SECTION 32 80 00**

3.06 Cleaning

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from irrigation system installation.
- B. Extreme care shall be taken by the landscape contractor when backfilling of trenches. They shall be left flush with the existing surrounding soil level. Tamp soil and rake level to make level bed for turf to re-establish.

END OF SECTION

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

DIVISIONS 00 AND 01 ARE A PART OF THIS SECTION

PART 1 GENERAL INFORMATION

1.01 SUMMARY

- A. Inclusions:
 - 1. Provisions set forth in Divisions 0 and 1;
 - 2. Soil preparation;
 - 3. Trees, plants, and ground covers;
 - 4. Planting mixes;
 - 5. Mulch and planting accessories;
 - 6. Maintenance;
 - 7. Submittal preparation;
 - 8. Clean up.
- B. Related Sections:
 - 1. Section 32 80 00: Irrigation Systems

1.02 QUALITY ASSURANCE

- A. Plant names indicated shall comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature.
- B. Names of varieties not listed conform generally with names accepted by the nursery trade.
- C. Provide stock true to botanical name and legibly tagged.
- D. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be measured as it stands in its natural position.
- E. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project for a minimum of 2 years.
- F. Stock furnished shall be at least the minimum size indicated.
 - 1. Larger stock is acceptable, at no additional cost, providing that the larger plants will not be cut back to size indicated.
- G. Plants may be inspected and approved at the place of growth, for compliance with specification requirements for quality, size, and variety.
 - 1. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.
- H. Warranty:
 - 1. Warrant plant material to remain alive and be in healthy vigorous condition for a period of 1 year after completion and acceptance of entire project.
 - a. Inspection of plants will be made by the Landscape Architect at completion of planting.

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

2. Replace plants that are dead as determined by the Landscape Architect, or are in an unhealthy or unsightly condition, or have lost their natural shape due to dead branches, or other causes, at the Contractor's expense.
 - a. Warrant all replacement plants for 1 year after installation.

1.03 PROJECT CONDITIONS

- A. Notify Landscape Architect at least 7 working days prior to installation of plant material.
- B. Protect existing utilities, paving, and other facilities from damage caused by landscape operations.
- C. In the event that quantity discrepancies or material omissions occur in the plant materials list shown on the drawings, the planting plans shall govern.
- D. The irrigation system will be installed prior to planting.
 1. Locate, protect, and maintain the irrigation system during planting operations.
 2. Repair irrigation components damaged during planting operation at the Contractor's expense.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Provide plants typical of their species or variety; with normal, densely developed branches and vigorous root systems.
 1. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation.
 2. Plants shall have a fully developed form without voids and open spaces.
 - a. Plants held in storage will be rejected if they show signs of growth during storage.
- B. Container-growth stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm, and whole.
 1. No plants shall be loose in the container.
 - a. Container stock shall not be pot bound.
- C. Provide tree species that mature at heights over 25'-0' with a single trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.
- D. Plants planted in rows shall be matched in form.
- E. Plants larger than those specified in the plant list may be used when acceptable to the Landscape Architect.
- F. The height of the trees, measured from the crown of the roots to the top of the branch, shall not be less than Industry standard for each plant species and variety.
- G. No pruning wounds shall be present with a diameter of more than 1" and such

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

wounds must show vigorous bark on all edges.

1. Evergreen trees shall be branched to the ground.
- H. Shrubs and small plants shall meet the requirements for the industry standard spread and height for said species and variety.
1. The measurement for the height shall be taken from the ground level to the average height of the plant and not the longest branch.
 2. Single-stemmed or thin plants will not be accepted.
 3. Side branches shall be generous, well-twiggged, and the plant as a whole well-bushy to the ground.
 4. Plants shall be in a moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.
- I. Replace plant materials found dead or not in a healthy growing condition.
1. Plants that die or lose more than 30% of their original leaves shall be replaced under this Section.
 2. Replace plant materials of same size and species, with a new warranty commencing on date of replacement.
- J. Trees, Plants, and Ground Cover shall be species and size-identified in plant schedule, grown in climatic conditions similar to close locality of the work.
- K. Plants shall be symmetrical, typical for variety and species, sound, healthy, vigorous, free from plant disease, insect pests or their eggs, excessive abrasions or other objectionable disfigurements, and shall have healthy, normal root systems, well filling their containers, but not to the point of being root bound. Tree trunks shall be sturdy and well hardened off.
- L. Substitutions for the indicated plant materials will be permitted.
1. Provided the substitute materials are approved in advance by the Landscape Architect and the substitutions are made at no additional cost to the Owner.
 2. Except for the variations so authorized, all substitute plant materials shall conform to the requirements of these specifications.
 3. If accepted, substitute materials are of less value than those indicated or specified, the Contract price will be adjusted in accordance with the provisions of the Contract.
- M. Plant Inspection and Rejection: Root condition of plants will be determined by the Landscape Architect through the removal of earth from the roots of at least two (2) plants but not more than 2% of the total number of species from each source.

2.02 SOIL AMENDMENTS

- A. Areas to be planted and irrigated shall receive soil amendments.
1. The following soil amendments shall be incorporated into the soil prior to planting.
 - a. Four (4) cubic yards compost shall be incorporated per 1000 sq. ft. of soil surface area and rotor-tilled to depth of 6".
 - b. Live Earth Liquid 6%- Drench at 32 oz. per 1000 sq. ft

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

- c. Humate soil conditioner - @ 500 lbs per 1000 sq. ft.
spread evenly after tilling, grading, and before planting.
- d. Live Earth Iron 10 (5-0-0) product - @ 15 lbs per 1000 sq ft.
- 2. A copy of delivery slips on all materials used on the project shall be delivered to the authorized District representative at time of material delivery to site. Delivery will not be allowed without delivery slips on any items.
- 3. If import soil is to be used, a soil suitability and fertility analysis of the soil shall be conducted by a soils laboratory. Submit test results and recommendations for soil amendment to the Landscape Architect for review. If recommendations for soil amendment according to test results exceed the above quantities, the Contractor will be reimbursed for an extra based on unit costs submitted with original bid for soil amendments required in any of the above quantities.

PART 3 EXECUTION

3.01 PREPARATION

- A. Remove foreign materials, plants, roots, stones, and debris from areas to be planted.
 - 1. At time of planting, areas to be planted shall be free of stones, stumps, roots, or other deleterious matter 1" in diameter or larger and shall be free from all wire, plaster, or similar objects that would be a hindrance to planting or maintenance.
- B. Protect existing underground improvements from damage.
- C. Any and all contaminated soil shall be removed and replaced with acceptable fertile import soil as determined by soils analysis.
- D. Cultivate all planting areas by ripping to depth of 12 inches with an agricultural implement designed for that purpose. Rip area in two directions, perpendicular to each other.
 - 1. Repeat cultivation areas where equipment has compacted subgrade.
- E. Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds.
 - 1. Provide plant pits twice the width of the diameter of the root system for all the trees and shrubs.
 - 2. Depth of pit shall accommodate the container root ball, such that the top of the root crown shall be 1" above finish grade.
 - 3. Scarify the bottom of the pit to a depth of 4".
 - 4. Remove excavated materials from the site.

3.02 DELIVERY, STORAGE, AND HANDLING

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

- A. Deliver fertilizer materials in original, unopened, and undamaged containers, showing weight, analysis, and the name of manufacturer.
- B. Store in manner to prevent wetting and deterioration.
- C. Take precautions in preparing plants for moving.
 - 1. Spray deciduous plants in foliage with an approved "Anti-Desiccant" immediately after digging to prevent dehydration.
 - 2. Dig, pack, transport, and handle plants with care to ensure protection against injury.
 - 3. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrive, the certificate shall be filed with the Landscape Architect.
 - 4. Protect plants from drying out.
 - a. If plants cannot be planted immediately upon delivery, properly protect them with oil, wet peat moss, or in manner acceptable to the Landscape Architect.
 - b. Water heel-in plantings daily.
 - 5. No plant shall be bound with rope or wire in a manner that could damage or break the branches.
- D. Cover plants transported on open vehicles with protective covering to prevent wind burn.
- E. Reject plants when ball of earth surrounding roots has been cracked or broken preparatory to or during planting.
- F. Provide dry, loose topsoil for planting bed mixes. Frozen or muddy topsoil is not acceptable.

3.03 INSTALLATION

- A. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.
- B. Locate plants as indicated or as approved in the field after staking by the Contractor.
 - 1. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until alternate plant locations have been selected.
- C. Set plant material in the planting pit to proper grade alignment.
- D. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure.
- E. Set plant material 1" above the finished grade.
- F. No filling will be permitted around trunks or stems.
- G. Backfill the pit with planting mixture.
 - 1. Do not use frozen or muddy mixtures for backfilling.
 - 2. Form a ring of soil around the edge of each planting pit to retain water.

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

3. Backfill mix shall be equal parts of native soil and sand, plus the soil amendments indicates below.
4. The Backfill mix blend to contain the following:
 - a. Humate Soil Conditioner - 45% humic @ approx. 1lb or 2 cups per gallon container size.
 - b. 'Aquasmart Pro' moisture retention product at the following rates -

36" box-	5 cups
5 gallon-	1/3 cup
1 gallon-	2 tablespoons
- H. Space ground cover plants in accordance with the plans.
 1. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants.
- I. Mulching:
 1. Install 3" thick layer of decomposed granite mulch within all shrub beds, immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.
 2. Tree and shrub root crowns shall not be covered with mulch material.
- K. Tree Staking:
 1. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
 2. Staking:
 - a. Stake all trees immediately after lawn seeding or sodding operations, and prior to acceptance.
 3. All work shall be subject to acceptability of the Landscape Architect.
- L. Pruning:
 1. Pruning branches of deciduous stock after planting to balance the loss of roots and preserve the natural character appropriate to the particular plant requirements.
 - a. In general, remove 1/4 to 1/3 of the leaf bearing buds. Proportion shall, in all cases be acceptable to the Landscape Architect. Remove or cut back broken, damaged, and non-symmetrical growth of new wood.
 2. Multiple Leader Plants: Preserve the leader that will best promote the symmetry of the plant.
 - a. Cut branches flush with the trunk or main branch, at a point beyond a lateral shoot or bud a distance of not less than 1/2 the diameter of the supporting branch.
 - 1) Make cut on an angle.
 3. Prune evergreens only to remove broken or damaged branches.

3.04 INSPECTION

- A. Examine proposed planting areas and conditions of installation.
 1. Do not start planting work until unsatisfactory conditions are corrected.

3.05 MAINTENANCE

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

- A. Planted and turf areas will be inspected at completion of installation and accepted to compliance with specified materials and installation requirements.
- B. After all work indicated on the drawings or herein specified has been completed, inspected, and approved by the Landscape Architect, the Contractor shall commence a ninety (90) day Maintenance Period.
 - 1. This ninety (90) day Maintenance Period shall occur within the specified project completion timeframe.

3.06 WORK IN PROGRESS

- A. Contractor shall continuously maintain areas included in the Contract during the progress of the work and until final acceptance of the work.
- B. During Maintenance Period the contractor shall maintain the site and this includes all mowing (at height approved by District), watering, reseeding, mulching, cultivating, spraying, and trimming necessary to bring the planted areas to a healthy growing condition, and any additional work needed to keep the areas neat, edged, and attractive.
 - 1. This shall be required on a weekly basis.
- C. During the maintenance period, the Contractor, at his own expense, shall replace any plant indicating weakness or the probability of dying.
- D. All basins around shrubs and trees shall be maintained at a four (4) inch depth throughout progress of the work, unless otherwise instructed by the District's authorized representative.
- E. Tree stakes that for any reason are damaged or rendered inadequate for support shall be repaired and restored to their original condition.
- F. Constant diligence shall be maintained for the advent of disease, insects, and/or rodent infestation, and proper preventative or control measures taken.
- G. All shrubs and trees shall be maintained in their natural shapes.
 - 1. Tall or scraggly branches shall be thinned out where necessary.
 - 2. In no case shall trees or shrubs be trimmed by heading or shearing.
 - 3. Any plants severely pruned in this manner shall be removed and replaced at the Contractor's expense.
- H. Tree and Shrub Liquid Program to be applied with the installed fertigation unit:
 - 1. Live earth Emerald Green- @ 5 gallons per acre, (12-16 oz per 1000 sq.ft.) (Apply in April and September as needed).
- I. Tree and Shrub Granular Program:
 - 1. Live Earth 8-2-4 Product - @ 10 lbs per 1000 sq.ft. Apply twice annually.
 - 2. Live Earth Humate Soil Conditioner - @ 50 lbs per 1000 sq. ft. Apply in October.
- J. At completion of maintenance period, all areas included in the Contract shall be substantially clean and free of debris.

TREES, PLANTS AND GROUND COVER
SECTION 32 93 00

1. All plant materials shall be alive, healthy, and free of infestations.

K. The Contractor, at his expense, shall repair any erosions or slippage of soil caused by watering.

3.07 CLEAN UP

A. All walks, curbs, and gutter shall be kept clear of debris, mud, dust, and standing water by sweeping, mopping, or hosing down, as required to maintain cleanliness throughout.

3.08 NOTICE

A. The Contractor, within fourteen (14) days of written notification by the District's authorized representative, shall remove and replace all guaranteed plant materials that for any reason fail to meet the requirements of the guarantee.

1. All plant material replaced shall be guaranteed for the original period, starting from the date of replacement.

B. Written Notice:

1. At the end of the specified Maintenance Period, the Contractor shall present written notice to the District's authorized representative that he has completed the required maintenance, and upon acceptance by District, any further maintenance will be the responsibility of the District.

END OF SECTION