

SECTION 01 11 00

SUMMARY OF WORK

PART 1 – GENERAL

1.01 SUMMARY

A. This Section describes the work to be performed under Contract Documents consisting of Specification No HD-3195 and shown on Drawings listed on HD-10-02464 for Harbor Department of the City of Long Beach, California.

1. Mobilize, staging and site prep.
2. Demolish and removal of indicated items.
3. Excavate for utility work after coordinating outages with the port.
4. Install utilities and site concrete.
5. Install pump shop improvements, walls, plumbing fixtures, equipment, and finishes.
6. Complete project closeout activities.

B. Per the requirements of this Section, Contractor shall furnish all labor, transportation, equipment, services, and incidentals necessary for work including, but not limited to, the following:

1. General selective demolition, removal, and disposal.
2. Modifications to existing structures.

C. General Activities:

1. Comply with all permit and regulatory requirements.
2. Provide environmental protection measures, including a safe work environment for the protection of onsite workers' health and safety.
3. Protect existing utilities and pipelines, as shown on the Drawings.
4. Implement quality control procedures to assure construction products meet the Contract Documents.
5. Obtain approval from the Engineer for any work deviations from the Contract Documents prior to commencing the work.
6. Provide written notification and redlined drawings to the Engineer for any construction deviation from the Contract Documents on a daily basis.

1.02 DEFINITIONS

- A. Cal-Haz Sump Material: Sump material characterized for offsite disposal as Non-Resource Conservation and Recovery Act (RCRA) California Hazardous (Cal-Haz) material.
- B. Debris: Combustible and non-combustible wastes such as ashes and waste materials resulting from demolishing, construction or maintenance work, bushes, leaves and tree trimmings.
- C. Demolish or Remove: Detach items from existing improvements and legally dispose of them offsite unless otherwise specified or indicated on the Contract Drawings.
- D. Dust: Soil and other debris that has eroded and has been transported by wind.
- E. Erosion: Wearing-away of a surface primarily by wind or water. Occurs naturally as a result of weather or runoff but may be intensified by clearing, grading, or excavation of the land surface.
- F. Existing Improvements to Remain or Protect in Place: Existing improvements that shall not be removed, salvaged, or disposed.
- G. Non-Hazardous Sump Material: Sump material characterized for offsite disposal as non-hazardous material.
- H. Rubbish: Combustible and non-combustible wastes such as paper, boxes, glass, well casing, metal, lumber, and cans.
- I. Sediment: Soil and other debris that has eroded and has been transported by runoff.
- J. Solid Waste: Rubbish, debris, garbage, and other discarded materials as defined in 40 CFR 261.2, except "Hazardous Waste" as defined herein, resulting from industrial, commercial, and agricultural operations and from community activities.
- K. Sump Boundary: Horizontal limit of sump material as shown on the Drawings.
- L. Sump Limit: Sump material excavation daylight line beyond sump boundary to include required side slope as shown on the Drawings.
- M. Separable Overburden: Fill material, within the sump boundary and over sump materials, that is to be excavated separately from underlying sump materials, as shown on the Drawings.
- N. Storm water Grading: Smooth and trim the surface of a cut or fill to the indicated lines and grades within the specified tolerances.
- O. Sump Material: Contaminated material, within the sump boundary, that is to be excavated from the sump boundary, as indicated on the Contract Drawings after the removal of separable overburden.

1.03 PROJECT INFORMATION

- A. Project Identification: POLB Pier G Maintenance Building C Pump Shop Conversion, Const. Contract # HD-S3195
 - 1. Project Location: 725 Harbor Plaza, Long Beach California, 90802
- B. Owner: City of Long Beach.
 - 1. Owner's Representative: Vicente Lopez

1.04 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
1. Remove and replace with new:
 - a. Remove overhead door and infill with walls.
 - b. Electrical Lighting, switches, receptacles and Exit signs.
 2. Remove and reinstall:
 - a. Owner's equipment relocation
 3. Improvements:
 - a. Bridge crane, footings
 - b. Exterior wall infill of overhead door opening, Window
 - c. Restroom, Office. Interior doors, hardware and windows
 - d. Interior finishes, Casework and countertops
 - e. Electrical improvements
 - f. Includes installation of test benches
 - g. HVAC equipment, radiant heat, and improvements
 - h. Roof penetrations and patching
 - i. Plumbing floor drains, cleanouts, sinks, eyewash, and the associated sanitary piping
 - j. Fire Protection
 - k. Utility extensions
 - l. Exterior cleaning and sealing
 - m. Additional scope as indicated on Drawings
- B. Type of Contract:
1. Project will be constructed under a single prime contract.

1.05 REFERENCES

Environmental and Geotechnical Reports included in Appendix CC.

1.06 SCHEDULING

A. Phases of the Work

1. Perform work in accordance with the phasing indicated in the Drawings. The Construction Phasing Plans shall not relieve the Contractor of responsibility for scheduling the work or completion of the work in accordance with specified time frames for the interim milestones and project completion dates.

B. Site work hours

1. Operation of marina interim parking lot shuttle shall be in accordance with Section 01 50 00, "TEMPORARY FACILITIES AND CONTROLS".
2. All other site work shall be in accordance with SC-6.2, "Contractor Work Schedule".

1.07 SUBMITTALS

Ensure that all submitted items are in compliance with the Contract Documents before actual submittals. Individual requirements for submittals are described in the pertinent sections of the Technical Specifications.

A. Contractor correspondence

1. Sequentially serialize and date all correspondence to the Engineer. Furnish original and one copy of all correspondence.

B. Contractor personnel requirements

1. Furnish a list of Contract supervisory personnel for the Contractor and each Subcontractor, including addresses and telephone numbers for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

C. Pre-Construction Meeting

1. After award of the Contract but prior to commencement of any work at the Work Site, meet with the Engineer to discuss and develop a mutual understanding relative to the administration of the Contract, coordination with other contractor's value engineering and safety programs, preparation and submission of the schedule of prices, shop drawings and other submittals, scheduling, programming and execution of work. Major Subcontractors who will be engaged in the work shall also attend.

D. Daily reports by Contractor

1. Prepare and deliver to the Engineer, on a daily basis, reports recording operations, labor and equipment available and used, materials and equipment received each day, and problems encountered on a form acceptable to the Engineer. If Contractor fails to submit reports daily, City may withhold payments for undocumented work until Contractor submits the required information. Make available any records as requested by Engineer to verify that the reports are accurate.

1.08 SITE CONDITIONS

A. Location

1. The work shall be located at 725 Harbor Plaza, Long Beach, CA 90802 The Work Site is owned by the City of Long Beach.

B. Existing Site Conditions

1. The Work Site is located in an industrial/commercial area, which mainly consists of tourism, container shipping yards, rail yards, maintenance buildings, and rail yards.

C. Known Site Health and Safety Hazards

1. None identified

D. Access to Site

1. Contractor and all subcontractors and suppliers shall conduct all business via ingress and egress at the Work Site entrance located at 725 Harbor Plaza as shown on the Drawings.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 01 31 19

PROJECT MEETINGS

PART 1 – GENERAL

1.01 SUMMARY

Contractor shall attend and participate in project meetings, as specified and shown, including the following:

- A. Pre-Construction meeting that shall be held in accordance with requirements stated in this Section.
- B. Construction progress meetings that shall be held on a weekly basis for collection and dissemination of information related to the work. Frequency may be reduced when the workload allows.
- C. Additional project and construction coordination meetings scheduled on an as-needed basis by the Engineer.

1.02 ATTENDANCE

There is a cost to the City for furnishing management and support staff to attend project meetings. If the Contractor fails to attend regularly scheduled meetings, the Contractor will be charged for the City's unproductive time.

1.03 PRE-CONSTRUCTION MEETING

- A. Pre-construction meeting will be scheduled by the Engineer.
- B. Engineer will distribute a notice of preconstruction meeting, along with an agenda of subjects to be addressed, at least seven (7) days prior to meeting.
- C. Contractor's Principal Project Manager and Superintendent shall attend meeting.
- D. Following is a minimum agenda for preconstruction meeting:
 - 1. Engineer's responsibility at meeting:
 - a. Explain Project organization and primary contacts.
 - b. Explain and discuss safety, insurance, laws, codes, maintenance of traffic, permits, quality control, inspection and related items.
 - c. Discuss procedures for processing submittals and requirements for submittals in electronic format.
 - d. Review Contractor's and Engineer's roles and obligations regarding documentation, inspections and notifications required by permits.
 - e. Discuss monthly estimate cutoff dates.

- f. Discuss partial and final payment.
- 2. Contractor's responsibility at meeting:
 - a. Introduce Contractor's representatives and briefly describe each person's responsibilities. Furnish list of contact personnel and emergency contact information.
 - b. Discuss use of office, storage areas and construction areas.
 - c. Define arrangements for safety, first aid, emergency actions and security.
 - d. Discuss construction methods and coordination of work within the provisions of the Contract Documents.
 - e. Submit and discuss a draft baseline schedule and the submittal schedule for review and approval by the Engineer. Refer to Section 01 33 00, "SUBMITTAL PROCEDURES" and Section 01 32 16, "NETWORK ANALYSIS AND PROJECT SCHEDULES" for schedule requirements.
 - f. Discuss coordination and notification for utility work, and use of onsite utilities.
 - g. Discuss coordination with work of other contractors, subcontractors and procedures for sharing access to Work Site.
 - h. Discuss deliveries of major construction equipment and any long lead time materials not furnished by the City.
 - i. Discuss breakdown of lump sum items as described in the Schedule of Values.
- E. Explanations provided by Engineer do not amend, supersede or alter terms or meaning of any Contract Documents, and Contractor shall not claim reliance on such explanations as a defense to any breach or failure by Contractor to perform as specified in Contract.

1.04 CONSTRUCTION PROGRESS MEETING

- A. Progress meetings shall be coordinated between Engineer and Contractor.
- B. Meetings will be scheduled weekly, and more often as necessary for competent and timely execution of work under Contract. Meetings will be chaired by Engineer.
- C. Furnish schedule updates in accordance with Section 01 32 16, "NETWORK ANALYSIS AND PROJECT SCHEDULES".
- D. At least once per month during the Progress Meeting, the Contractor shall provide the opportunity for the Engineer to review the Contractor's redline documents.

1.05 MEETING MINUTES

Engineer will prepare meeting minutes. Submit corrections to minutes prior to the date of the next meeting. These minutes, along with project correspondence, shall serve as project record.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 01 32 16

NETWORK ANALYSIS AND PROJECT SCHEDULES

PART 1 - GENERAL

1.01 SUMMARY

This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

- A. Preliminary 60-Day Schedule
- B. Baseline Schedule
- C. Daily Construction Reports
- D. Monthly Project Status Updates
- E. Schedule Revisions
- F. Recovery Schedules
- G. Look-Ahead Schedules
- H. Delays and Extensions of Time
- I. Weather Delay
- J. Submittal Schedule
- K. Ensure adequate planning and execution of all Work by the Contractor.
- L. Assure coordination of work of the Contractor and various Subcontractors and suppliers at all tiers.
- M. Establish a standard against which satisfactory completion of the Project can be measured by the City.
- N. Assist City in monitoring progress. The terms City and Engineer are both used interchangeably to suggest one entity in itself.
- O. Aid in assessing the impact of any changes to the Contract.
- P. Provide justification for Contractor's progress payments.

1.02 DEFINITIONS

The following definitions shall apply to all Contract Documents.

- A. Activity – An activity is a discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. The activity must be

performed in order to complete the Work defined in the Contract. An activity has interrelationships, and they consume time and resources.

- B. Activity Calendar – Defined work periods, non-work periods, and holidays that determine when project activities may be scheduled. Multiple calendars may be used for different activities, which allows for more accurate modelling of the project work plan. e.g. 5-day work week calendar vs. 7-day work week.
- C. Activity Code – Any combination of letters, numbers, or blanks which describe and identify any activity or task shown on the schedule. Customized codes are assigned to activities to facilitate report organization, data searches, etc.
- D. Accepted – Meets the requirements of the Drawings, Specifications and terms of the Contract. Schedule submittal will be returned to the Contractor marked “No Exceptions Taken.” It should be noted that City’s acceptance of the Contractor’s schedule submittal does not relieve the Contractor from the responsibility of finishing the Project within the Contract Time.
- E. Acceptance Criteria – Implicit or explicit specifications that must be achieved for a product or service to be acceptable within the terms of the Contract or Agreement seeking its delivery. Review and acceptance by the Engineer shall not relieve the Contractor of responsibility for errors or omissions in such documents.
- F. Baseline Schedule – The initial Critical Path Method (CPM) schedule submitted by the Contractor based upon a reasonable sequence of logical activities, which represents the Contractor’s plan for the execution of the Work.
- G. Calendar - Workdays and holidays (non-work days) defined for a project that determines when an activity can be scheduled.
- H. Calendar Day - There are 365 or 366 calendar days in a year regardless of project’s calendar.
- I. Change Order – A document directing modification to the Contract Documents that must be approved by the City before it becomes an authorized change to the Contract.
- J. Concurrent Delay – Two or more critical path activity delays that occur during the same time period.
- K. Constraint – A scheduling restriction electronically imposed on an activity within the scheduling software.
- L. Contract Completion Date – The date the Contractor is contractually obligated to complete the Work of the Contract, including any authorized time extensions.
- M. Contract Time – The number of calendar days stipulated in the Contract Documents in which the City requires the Work to be completed.
- N. Contractor Delay – A delay extending the time required to complete an activity, caused by and within the control of the Contractor, subcontractors at any tier or suppliers.
- O. Critical Path – The sequence of activities yielding the longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.
- P. Critical Path Method (CPM) – It is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of project.

- Q. Current Schedule – The accepted project schedule submittal through the previous monthly reporting period.
- R. Day – A contract day is a calendar day. A seven-day contract duration beginning on a Monday concludes on the ensuing Sunday (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday). All calendar days comprised within the schedule duration are available to the Contractor for the implementation of the Contract. Please note that special circumstances, impacts and costs may be applicable to working on weekends (Saturday and Sunday) and holidays.
- S. Data Date – The day after the Month End Cut-Off, through which progress updates will be calculated. Everything occurring earlier than the data date is actual work completed and everything on or after the data date is work planned to be completed.
- T. Early Completion Date – The Contractor's scheduled completion date precedes the Contract Completion Date.
- U. Event – The starting or ending point of an activity.
- V. Float – The measure of leeway in starting and completing an activity.
1. Float time is not for the exclusive use or benefit of either the City or the Contractor, but is an expiring resource available to both parties on a non-discriminatory basis. If required to meet specified milestones, either party may utilize the float. Adjustments to milestones and/or Contract time will only be authorized by change order and only to the extent the claimed adjustments exceed total float along the critical path of the current monthly schedule submittal in effect at the time of the claimed adjustments.
 2. Free Float is the amount of time an activity can be delayed without affecting the early start of the following activity.
 3. Total float is the measure of leeway in starting or completing an activity(s) without affecting the Contract Completion Date and/or milestones.
 4. Suppression techniques: Pursuant to the float-sharing requirements of this Section, use of float suppression techniques such as preferential sequencing or logic, special lead/lag time restraints, and extended activity times or durations are prohibited. The use of float time disclosed or implied by the use of alternate float suppression shall be proportionally shared to City and the Contractor. The use of any technique solely for the purpose of suppressing float will result in the rejection of the submitted schedule(s).
- W. Fragnet – A section or fragment of the network diagram comprising a group of activities used to illustrate changes and impact to the whole network. It is a partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- X. Level of Effort or Hammock – An aggregate or summary activity spanning two or more activities and reported at a summary level.
- Y. Look-Ahead Schedule – A weekly schedule indicating the previous week's work and the work planned for the next two weeks. This is in greater detail than the network schedule.
- Z. Milestone – A marker in a schedule network, which is typically used to mark a point in time or denote the beginning or ending of a sequence of activities. A milestone is linked with other scheduled activities via logic ties. A milestone consumes no time or resources.

- AA. Month End Cut-Off – The last calendar day of the month or a day negotiated with the Engineer.
- BB. Narrative Report – A written text report that addresses the project status and issues. The narrative shall include appropriate details to address the following as needed: project progress, potential problem areas, current and anticipated delaying factors and their impact, actions taken or proposed, proposed changes in schedule logic, extension or contraction of activities, proposed addition or deletion of activities, explanation for changes in the critical path, explanation for changes in scheduled completion date, out of sequence work, and other topics related to job progress or scheduling.
- CC. Negative Float – Having a net negative float condition for the overall Critical Path indicates the project is behind schedule.
- DD. Network Diagram – A graphic diagram of a network schedule, showing activities and activity relationships.
- EE. Out of Sequence Progress - Work that is completed in a sequence contrary to that which has been established in the schedule.
- FF. Progress Status Update Schedule – The most current schedule in effect, which incorporates actual progress for sequence of activities to date, projected completion dates and remaining durations.
- GG. Recovery Schedule –In case that Work falls behind schedule due to Contractor's actions to extent that any of the milestones or the project completion dates will not be met, the Contractor shall submit a modification to schedule to recover all Contract dates. The Contractor's plan to bring the Contract Work back on schedule. This may include a revised CPM schedule and additional manpower and equipment.
- HH. Revised Baseline Schedule – Incorporates revisions to the Baseline Schedule subject to the approval of the Engineer.
- II. Schedule Completion Date – The Contractor's scheduled completion date as shown on the Baseline Schedule, Progress Status Update Schedule or Schedule Revisions submittal.
- JJ. Schedule Revisions – Progress Status Update Schedule with proposed logic changes for future work, correction of out of sequence work, modifications, and approved change orders and/or time extensions.
- KK. Time Impact Analysis – Provides guidelines and methods to access and quantify the effects of an unplanned event or events on the Contract Completion Date or required interim milestone completion dates.
- LL. Total Float – The amount of time that an activity(s) may be delayed without delaying the Contract Completion Date.
- MM. Weather Delay Day – Impact of precipitation, wind or other inclement weather conditions to Critical Path Activity(ies) for four (4) hours or more on a work day or extended inclement weather impact in continuation of a Critical Path Activity.

1.03 SUBMITTALS

- A. Schedule submittals shall be clear, neat, legible, and reproducible. These documents shall include a narrative explaining the schedule, a color bar chart, and time-scaled network diagram. All reports in the schedule submittals shall be in PDF format and submitted using the "Construction Management Software" as defined in SC-7 of the Special Conditions. Digital,

PDF submittals shall be generated directly from the software being used (i.e. P6, Word, Excel, etc.) in lieu of printing and scanning the document(s). The schedule being submitted shall be “backed up” by exporting the schedule to a ‘xer’ or native file and include the backup file and any associated layouts with the submittal. The P6 export file shall be compatible with the latest version of P6 used by the City or as requested by the Engineer.

- B. The schedules, tabular reports and narratives shall include the project name, specification number, data date, submittal number, and date of the submittal on each page.
- C. The Contractor shall re-submit all revised schedules and tabular reports within seven (7) calendar days after receipt of Engineer’s response if the Engineer requires change and/or additional information.
- D. The Contractor shall maintain an up-to-date Progress Status Update Schedule using the scheduling software per Article 2.01, “Software”, herein. All updates shall be available to the Engineer.
- E. The following is a summary of the submittal requirements. The details of each submittal requirement are discussed at length in the respective sections.
 - 1. Scheduler’s qualifications including resume shall be submitted with four (4) professional references within fifteen (15) calendar days of the execution of the Contract.
 - 2. Preliminary 60-Day Schedule, including mobilization, all submittal activities, long lead items, and equipment procurement activities, shall be submitted at the Pre-Construction Meeting.
 - 3. A list of non-work days shall be submitted at the Pre-Construction Meeting.
 - 4. The Baseline Schedule shall be accurate and in sufficient detail to include the full scope of Work and all activities required to complete the project within the timelines stipulated in the Contract.
 - 5. Project Baseline Schedule submission timing requirements can be found under Special Conditions, SC-6.3 Milestones.
 - 6. The schedules shall reflect any and all City activities such as review times and third party activities per Specification Section 01 33 00, unless noted otherwise.
 - 7. At least one review cycle for all key submittals associated with critical path activities identified in the Baseline Schedule, including Baseline Schedule submittal identified in the schedule. The Contractor shall ensure the Baseline Schedule is fully capable of absorbing additional submittal review durations, without affecting the Contract durations.
 - 8. Look-Ahead Schedules and Progress Status Update Schedules shall be submitted weekly and monthly, respectively, using the scheduling software.
 - a. Look-Ahead Schedules shall be formatted as requested by the Engineer and submitted for the weekly progress meetings.
 - b. Progress Status Update Schedules, tabular reports, and narratives shall be submitted by the end of the month for the month-end review.
 - 9. If City finds schedule reports provided by the Contractor insufficient, then City may reject submittal and require additional reports with resubmittal.

10. A Recovery Schedule shall be submitted if the Work falls behind schedule as indicated by negative float on the Progress Status Update Schedule or Schedule Revisions.
 11. Final As-Built Schedule shall be submitted within thirty (30) calendar days of Substantial Completion of the Contract or prior to the Affidavit of Final Completion, whichever comes first.
 12. Written narratives shall be submitted with every schedule submittal. The narratives shall include sufficient detail to explain the Contractor's schedule submittal as detailed in the definition "narrative report." Narrative shall provide City with all information necessary to perform a complete and accurate review.
- F. City requires fourteen (14) calendar days to review and respond to all Contractor's schedule submittals / re-submittals.

1.04 QUALITY ASSURANCE

- A. A scheduler shall be employed by the Contractor and shall have a minimum of five (5) years of experience using Primavera scheduling software, at least two years of which must be using P6.
- B. If the Contractor does not have a scheduler on staff, the Contractor shall provide a consultant scheduler fulfilling the outlined qualifications for the duration of the project.
- C. The scheduler provided by the Contractor shall cooperate with the Engineer and shall be available for the purpose of continuously monitoring, reporting, and maintaining the Contractor's project schedule.
- D. Within fifteen (15) calendar days of the execution of the Contract, the Contractor shall submit to the Engineer the scheduler's qualifications including resume of experience as a construction project scheduler, and at least four professional references that have had experience with the individual as a construction project scheduler. The Engineer has the right to reject the scheduler based upon lack of experience as required in this Specification or as requested by the Engineer.
- E. If the Engineer rejects the scheduler proposed by the Contractor, the Contractor shall, within seven (7) calendar days, provide another scheduler who meets the experience requirements stated herein.
- F. The approved scheduler shall stay on the project until the final As-Built Schedule is submitted to the Engineer. Any replacement of the approved scheduler shall be equal and approved by the Engineer.

1.05 CONTRACTOR RESPONSIBILITY

- A. Nothing in this, "Network Analysis and Project Schedules", Specification section shall be construed to be a usurpation of Contractor authority, responsibility and obligation to plan and schedule Work as Contractor deems necessary, subject to all other requirements of the Contract Documents.
- B. Contractor shall involve the subcontractors, manufacturers, suppliers, third party review/permit agencies and all others as required in the development and periodic updating of the schedule.

PART 2 - PRODUCTS

2.01 SOFTWARE

- A. Contractor shall utilize Primavera Project Management™ Professional® (P6) software (version 8.3 or later) by Oracle, to employ the Critical Path Method (CPM) scheduling in the development and maintenance of the construction schedule network using the Precedence Diagram Mode (PDM). If the current version of Primavera Scheduling Software (P6) used by the Contractor is greater than this version, then the Contractor shall notify City for acceptance. The Contractor shall save and export schedules in a version acceptable by the City before submitting for review.
- B. All schedule calculation rules, auto cost rules and resource calculation rules shall be in a format acceptable to the City. Schedule calculations are performed using the "Retained Logic" setting. To correct out of sequence work, Contractor shall use Schedule Revisions per provisions of Article 3.13-C.2, herein. Contractor shall use the whole integers for activity durations and lags.
- C. The Contractor shall use Oracle Primavera P6 Professional Project Management, the latest version, to develop and maintain all project schedules.

PART 3 - EXECUTION

3.01 MEETING REQUIREMENTS

The Contractor's Scheduler shall attend the following Meetings as required:

- A. Project Scheduling Meeting.
- B. Pre-Construction Meeting.
- C. Weekly Progress Meetings.
- D. Month-End Progress Status Update Schedule Meetings.
- E. Other Scheduling Meetings as required by the Engineer.

3.02 PROJECT SCHEDULING MEETING

- A. The Contractor and their scheduler shall make arrangements to attend a Project Scheduling Meeting to be scheduled by the Engineer.
- B. This meeting is an opportunity for the Engineer and the Contractor, along with the project scheduler, to discuss the scheduling specifications and the requirements. Contractor shall come prepared to review and discuss all project scheduling requirements and any concerns at this meeting.
- C. At the Project Scheduling Meeting, the Contractor and the project scheduler shall be prepared to review and discuss the schedule and sequence of operations including: As-Built Schedule development and maintenance; procedures of updating and revisions; and required submittals as specified in this Section and the Contract Documents.
- D. The Contractor shall describe their approach for achieving required interim and Final Completion milestone dates, as required by the Contract. Some of the topics of discussion would be: the schedule basis and assumptions that will be used in preparing the schedule submittal (such as crew sizes, equipment requirements, anticipated delivery dates, etc.), constraints, critical path activities, production rates, activities requiring overtime and/or additional shifts, activities containing time contingencies for impacts to be expected, potential problem areas, permits, coordination, and long lead delivery items (greater than 30 calendar

days from order to delivery). This information is required to be provided in a narrative format with every schedule submittal.

3.03 PRE-CONSTRUCTION MEETING

- A. After the execution of the Contract, the Engineer will schedule a Pre-Construction Meeting with the Contractor. This meeting may occur prior to issuance of Notice to Proceed, but after any Project Scheduling Meeting.
- B. Engineer will distribute a notice of Pre-Construction Meeting, along with an agenda of subjects to be addressed, at least seven (7) days prior to meeting.
- C. Contractor shall provide Preliminary 60-day Schedule at this meeting.
- D. Preliminary 60-day Schedule, Baseline Schedule, Look Ahead Schedules can be discussed.

3.04 SCHEDULE REQUIREMENTS

- A. The Work shall be scheduled to show the completion of the Contract within the stipulated Contract Time.
- B. The Contract Time establishes the period and duration in which the City expects the Work to be completed (see SC-6.3 Milestones). Any schedule that shows completion ahead of the Contract Time shall include additional supporting data to explain the basis of the shorter time for performance. The City may notify the Contractor that the Contract Time is being adjusted by a no-cost Change Order to reflect the shorter schedule duration, or may elect not to adjust the Contract Time and allow its use by all parties of the increased schedule flexibility that the shorter schedule represents. The City shall not be held responsible for any costs to the Contractor, actual or anticipated, resulting from the delay(s) of any cause that prevents completion of any part of the Work nor shall the City be obligated to incur any additional costs for administration or inspection of accelerated work by the Contractor.
- C. Schedule start date shall be Notice to Proceed.
- D. Contractor shall develop schedules on a standard 5-day work week calendar unless otherwise required by the Contract, or as requested in writing by the Contractor and approved in writing by the City.
- E. Include in the schedule calendars all holidays and/or non-work periods throughout the duration of the project.
- F. All schedules shall be based on early start dates.
- G. The Contractor shall establish a project-specific calendar for the Work. At the Project Scheduling Meeting, the Contractor shall provide a list of all non-work days.
- H. The Contractor shall submit P6 tabular reports (Schedule Report – Predecessors and Successors) and (Schedule Report – Sorted by Total Float) with every schedule submittal except the weekly Look-Ahead Schedule. Basic schedule and tabular reporting templates will be reviewed with the Contractor at the Project Scheduling / Pre-Construction Meeting. Other reports required monthly are discussed elsewhere in this Specification.
- I. All out of sequence logic conditions shall be corrected by adding new activities and relationships as opposed to deleting activities. Alternative approaches to correcting out of sequence activities shall be submitted for Engineer's review and acceptance prior to incorporating such corrections into the schedule.

- J. Any schedule submitted as a monthly Project Status Update that contains modifications will be rejected. Modifications shall be submitted under a separate schedule submittal referred to as Schedule Revisions submittal.
- K. Activities shall not be deleted from the schedule. If the scope of work associated with an Activity has been removed through a Change Order, the Contractor shall set the Activity's duration to zero, change the status to complete, and add description "DELETE per dated schedule revision" to the activity name, so that there is traceability.
- L. Failure to include any element of work required for performance of this Contract in the Preliminary 60-Day Schedule, Baseline Schedule, the Progress Status Update Schedule, Schedule Revisions, Recovery Schedules or Revised Baseline Schedule shall not excuse the Contractor from completing all Work required to achieve milestone completion within Contract Time, notwithstanding acceptance of schedule submittals.
- M. Schedule submittals shall not be used to notify the Engineer of City-caused delays or to request additional Contract Time. Formal notice and requests are required. The City's acceptance of a schedule that shows work being performed later than the Contract Completion Date shall not be construed as approval to extend the Contract Time.

3.05 ACTIVITY REQUIREMENTS

- A. A critical path activity shall be defined as any activity containing the least amount of total float (i.e., the longest path to complete the project). "Near critical" shall be defined as having a float value of five (5) days or less. Not more than 30% of activities in the schedule shall be critical and near critical without approval of the Engineer. The Contractor shall submit any constraints in the schedule to the Engineer for approval.
- B. All schedules shall be progressed using the appropriate Data Dates as defined herein Article 3.13, "Schedule Types." The activity ID numbering system, scope of work, and descriptions of activities shall remain the same as the accepted Baseline Schedule.
- C. Contractor shall perform due diligence to ensure that the activity durations and the associated work are in alignment.
- D. Activity descriptions shall briefly convey scope and location of work indicated. The description shall consist of a verb or work function (e.g.; form, pour, excavate), an object (e.g.; slab, footing), and area (e.g.; bent 200, northeast corner).
- E. The schedule shall include and account for any City activities such as review times, third party activities and any City-provided Contractor-installed or City-installed items.
- F. Activities shall be subdivided to the lowest detail and assigned appropriate coding structure. The coding structure should use Work Breakdown Structure (WBS) and/or Activity Coding structures and shall subdivide Area, Sub-Area, Discipline, Stage, Phase, and reference to Sheet and Specification Sections.
- G. No activity duration can exceed fifteen (15) calendar days, unless otherwise approved by the Engineer. Non work activities, such as procurement of materials, submittals, reviews, and/or fabrication of equipment are exempted from this requirement.
- H. Should a work activity require more than the allowed maximum duration of fifteen (15) calendar days, it shall be broken out into additional work activities. The Engineer reserves the right to require more detailed sequences of work activities as deemed necessary to review the schedule.

- I. With the exception of the first (start) and the last (finish) milestone activities, all other activities shall include both predecessors and successors where the logic is realistic and appropriate for the scope of Work. Contractor shall avoid redundant logic.
- J. The Contract milestones dates and any City furnished equipment availability dates, as described in the Contract Documents, shall be unique zero duration activities containing corresponding dates and logic ties. These activities shall be designed as either "start" or "finish" milestones. Each milestone activity shall constrain its dependent work. Calculation of constraint dates for milestones shall assume Notice to Proceed is given at day one (1).
- K. Leads or lags shall not be used when the creation of an activity will perform the same function (e.g. concrete cure time). Lag durations shall not have a negative value. The use of interrelation constraints such as leads and lags on activities shall be explained in the Narrative and submitted to the Engineer.
- L. Use of Mandatory Start or Finish Constraints, Start On, Expected Finish and Zero Total Float Constraints shall not be used in the Baseline Schedule, Schedule Revisions or Recovery Schedule without the approval of the Engineer. Finish milestones should be constrained to either a "Finish No Later Than" constraint or a "Finish On or Before" type constraint.

3.06 REQUIRED ACTIVITIES

In addition to detailed work activities, the following are some of the activities and milestones that shall be included in the schedules:

- A. Notice to Proceed.
- B. Mobilization.
- C. Procurement of critical materials and equipment.
- D. Potholing for regions requiring underground utility work.
- E. Submittal preparation (initial & resubmittals) and submittal review/re-review times.
- F. Mock-Ups.
- G. Inspection.
- H. Testing.
- I. Permits.
- J. Owner Training.
- K. Time related to furnishing products and materials with long lead times.
- L. City-provided material (whether installed or not).
- M. Third party activities.
- N. Coordination activities.
- O. Lead time related to utility services including, but not limited to, connection periods.
- P. Punch List and verification/sign-off activities leading to Substantial Completion.

- Q. Weather Allowance.
- R. Intermediate Milestones.
- S. LEED / Commissioning.

3.07 FILE STRUCTURE

- A. Contractor schedules shall use Work Breakdown Structure (WBS) and Activity Coding structures and shall subdivide by Area, Sub-Area, Discipline, Stage, Phase, Responsibility (i.e., City, Contractor, Subcontractor, or third-parties such as utility companies) and reference to Drawings and Specification Sections, for Engineer's review and acceptance.
- B. The Engineer will provide activity coding structure for Contractor at Pre-Construction Meeting or Project Scheduling Meeting to incorporate these codes into the construction schedule, to automatically and seamlessly integrate certain information from the Contractor's schedules directly into the City's master schedules and construction management software. The list of activities to be coded for auto reporting are NTP, Mobilization, Construction duration, Substantial Completion and Affidavit of Final Completion. The Contractor shall be notified if additional activities that require Engineer provided/accepted coding are required for inclusion in the schedule.
- C. Activity Codes, Activity IDs, and all report formats shall be developed by the Contractor and approved by the Engineer.
- D. Prior to submitting any electronic schedule files, the Contractor shall submit a protocol for naming of all electronic project schedules, schedule modifications, and time impact analysis.
- E. The Contractor is responsible for establishing detailed activities, activity duration, and sequencing of Work in developing the schedule submittals as defined by this Specification.
- F. Contractor shall maintain Engineer provided/accepted Activity Codes, Activity ID Codes, and Report Specifications on schedule submittals.

3.08 INCLEMENT WEATHER DELAYS

- A. The Contractor shall account for sufficient time for seasonally anticipated weather delays in the schedule by inserting a separate activity to represent a bank of inclement weather days, this bank shall be available for use through the entire duration of the Project. The duration of the inclement weather delay activity will be determined by calculating a minimum of two (2) Weather Delay Days per month. For partial months, account for zero (0) weather days for duration of one (1) through ten (10) calendar days, one (1) weather day for duration of eleven (11) through twenty (20) calendar days, and two (2) weather days for duration over twenty-one (21) calendar days. Activity Calendar will be assigned to the inclement weather delay activity.
- 1. For projects with Regions/Phases/Interim Milestones: The Contractor shall add a separate inclement weather delay activity for each individual Region/Phase/Interim Milestone. The duration of the inclement weather delay activity will be calculated based on the duration of each individual Region/Phase/Interim Milestone. The predecessor for the inclement weather delay activity shall be the last work activity(ies) in that respective Region/Phase/Interim Milestone completion. The inclement weather delay activity for each Region/Phase/Interim Milestone shall be on the Critical Path leading to that corresponding Region/Phase/Interim Milestone. Project Milestones are defined in Special Conditions SC – 6.3 Milestones. Weather Delay Days do not apply to administrative Interim Milestones e.g. Baseline Schedule submittals milestones or equipment/material procurement milestones.

2. For projects without Regions/Phases/Interim Milestones: Add a separate activity for the anticipated Weather Delay Days as described in Article 3.08A, herein. The weather delay activity shall be on the Critical Path, a successor to the last work activity(ies), and a predecessor to the Contract Substantial Completion milestone.
- B. The determination of a qualified Weather Delay Day will be a function of locally prevailing conditions to the affected work site. The impact of precipitation, wind or other inclement weather conditions to Critical Path Activity(ies) for four (4) hours or more on a work day or extended inclement weather impact in continuation of a Critical Path Activity shall qualify as a Weather Delay Day.
 - C. On days where adverse weather is encountered, the Contractor shall submit a list of all activities which were impacted and identify impacted activities were on the critical path. The Contractor must formally submit its written request for a Weather Delay Day within 24 hours of the end of each of the adverse weather days for the Engineer's review and approval to incorporate into the schedule as a weather delay. If this submittal falls on a planned non-work day, the information shall be submitted by the end of the next work day. Failure to submit the list of weather impacted activities within 24 hours will result in rejection of the Weather Delay Day request.
 - D. The Engineer will not grant a Weather Delay Day on non-scheduled workday. If the Contractor is approved to work on a specific weekend or holiday on a critical path activity, and an inclement weather activity prevents work from being performed, then that day can be claimed as a Weather Delay Day. If the effects of weather from a non-scheduled work day carry forward to a scheduled work day and impacts the Critical Path as noted above, then the scheduled work day will be considered impacted by weather.
 - E. In its monthly update schedule narrative, the Contractor must include a tabular log listing requested weather days, a column identifying the Engineer's approval, and number of ungranted days for each Interim Milestone and Substantial Completion. In the schedule updates, the Contractor shall reduce the duration of the weather delay activity by the number of weather days approved by the Engineer during that update period.
 - F. Excusable, non-compensable time extensions will be granted, in accordance with General Conditions GC-8.2 "Delays and Extension of Time", for weather delays to Substantial Completion milestone only after the allotted Weather Delay Days affecting the critical path work has been exhausted.

3.09 TOTAL FLOAT

- A. Total float is not for exclusive use or benefit of either the City or the Contractor, but is an expiring resource available to both parties on a non-discriminatory basis. Either party is entitled to use the float on a "first come, first served" basis, to meet Contract milestones or completion dates.
- B. It is expected that Contractor takes concerted effort to not deplete available total float due to poor planning of work. Contractor shall be cognizant that total float is available to allow for gratification of delays from unforeseen conditions and changes to scope of Work.
- C. Time Extensions will be granted only to the extent that delays or disruptions to the affected work paths exceed total float along those paths of the current schedule. Such delays or disruptions must also cause the end date of work to exceed current Contract Completion Date and must be beyond the control and without fault or negligence of the Contractor and/or any of the Contractor's subcontractors at any tier.

- D. In the event delays or disruptions impact an already negative float path, the Contractor shall not receive a time extension unless, and until, the activity with highest negative float is driven even further negative.
- E. Delays or disruptions shall not be basis for a time extension to this Contract unless, and until, such delays or disruptions are resolved as set forth in GC-8.2 "Delays and Extensions of Time".
- F. Pursuant to float sharing requirements of this Section, use of float-suppression techniques such as, but not limited to, preferential sequencing or logic, special lead/lag logic restraints, and extended activity times or durations is prohibited. Use of float time disclosed or implied by use of alternate float suppression techniques shall be shared to the proportionate benefit of the City and the Contractor. The use of any network technique solely for the purpose of suppressing float will be cause for rejection of schedule submittals.

3.10 TIME IMPACT ANALYSIS (TIA)

- A. The Contractor shall submit to the Engineer a stand-alone fragmented network schedule (Fragnet), excluding all unaffected activities, if the latest forecast completion dates of any milestone is, or will be, changed by change order activity, change order request, request for quote, unforeseen delays or alleged City-caused delays. Each Fragnet submitted shall be provided in PDF and P6 export (.xml) format and submitted using the City's Construction Management Software.
- B. Submittal shall show activities affected, date(s) delay or disruption occurred, or impacted productivity rates, and unmitigated impact(s) to schedule resulting from delay or disruption.
- C. Contractor shall utilize Time Impact Analysis (TIA) procedures, such as Window Analysis or other acceptable procedures, in submission of the TIAs. Improper presentation of TIAs will not be reviewed by the City.
- D. Timely submission of a TIA for delays and/or changes is critical. For a change negotiated on a lump sum basis, the Contractor shall submit a TIA with their cost proposal. Both cost and time shall be negotiated prior to the change being issued. For a change issued on a Cost plus Markup basis, the Contractor shall submit a TIA with their Cost plus Markup proposal, no later than forty-five (45) calendar days after the completion of the latest finish date for schedule activities impacted by the change. If the Contractor fails to submit the TIA for Cost plus Markup work within forty-five (45) calendar days from the latest completion date of the impacted activities, the Engineer may withhold up to twenty percent (20%) of the invoiced amount of costs until the TIA is submitted. If the Contractor determines that there is no schedule impact to changed work, the Contractor shall document this fact in their cost proposal and, in this case, no TIA shall be required.
- E. The Contractor shall submit an independent network of activities (Fragnet) showing the Contractor's plan to mitigate delay or alleged disruption and subsequent impact(s) to schedule. Submission of such Fragnets does not constitute permission to proceed with the plan.
- F. Insert the Fragnet into the most current project schedule, logically tying Fragnet to existing activities. If project schedule requires any modifications or corrections, make these prior to inserting Fragnet.
- G. The Contractor shall include a detailed written narrative with the submittal describing the circumstance(s) that caused the delay or disruption, and methodology used to determine extent of delay or disruption, analysis and the conclusion. Submit all relevant project documentation (correspondence, meeting minutes, photographs, etc.).

- H. Activities of revised portion(s) of schedule shall be properly connected to, and constrained by, previously existing predecessor and successor activities, as applicable. Band impacted activities in separate networks (Fragnets), indicating specific delay or impact issue, and submit to the Engineer for review.
- I. The Contractor shall combine the reviewed and accepted Fragnets into the current Schedule. The Engineer will review the aggregate impact to the critical path.

3.11 NARRATIVES

- A. Narratives prepared by the Contractor shall include sufficient detail to explain clearly and completely the specific submittal. The Schedule narratives shall address the following:
 - 1. The narrative shall offer the schedule basis and planning assumptions relative to any specific schedule submittal. This applies to all schedule submittals.
 - 2. The narratives shall state that the Contractor and the Engineer have reviewed and verified the on-site As-Built Drawings and Specifications to ensure that the schedule submittals are current with all the changes issued to date. Furthermore, the narrative shall state work that is actually completed and reflect progress along the critical path indicating whether the project is ahead, behind or on target in relationship to the Contract terms and conditions.
 - 3. If the Schedule submittals indicate an actual or potential delay to the Contract Completion Date or interim milestone dates as specified under Special Conditions, the Contractor shall identify the causes of delay(s), disruptions, or interruptions. The Contractor's narrative shall also provide an explanation of work affected and proposed corrective action to meet milestone dates involved or to mitigate potential delays or disruptions.
 - 4. The narrative shall discuss any added changes in scope, if applicable.
- B. The **Preliminary 60-Day Schedule** narrative shall address the Contractor's approach to mobilization, procurement, and construction during the first 60 calendar days by taking into account crew sizes by craft labor categories, equipment and material delivery, site access, submittals and permits.
- C. The **Baseline Schedule** narrative shall address the Contractor's approach to executing the scope of Work including procurement, long lead items, City-furnished items, third party coordination, equipment, materials, site access, interrelation activity constraints such as leads and lags, potential problem areas, weather sensitive activities, submittals, and permits throughout the duration of the project. The narrative report shall be comprehensive enough to explain the rationale of the project's critical path logics, durations and anticipated production rates for major activities on the critical path and near critical paths, phasing concepts, holidays and other non-work days, potential problem areas, permits, coordination with regulatory authorities, utilities separate work contracts and other parties, and long lead delivery items requiring more than 30 days from the date of order to delivery to the project site, and other applicable information.
- D. In addition, at the request of the Engineer, the Contractor shall furnish a detailed written explanation of the Contractors basis for specific durations, logic, phasing or other information. Such an explanation shall include Contractors rationale for selecting the number of crews, crew composition, crew shifts, construction equipment, materials and other similar factors.
- E. The **Schedule Revisions** narrative shall address the basis for any changes subsequent to the latest Progress Status Update Schedule, in terms of scope, activity, logic, activity duration, calendars and resources.

- F. The **Fragnet** narratives shall address, at a minimum, the circumstances that caused delay or disruption, and the methodology used to determine extent of delay or disruption.
- G. The final **As-Built Schedule** narrative shall address the basis for all logic or activity duration changes from the Baseline or the latest Revised Baseline Schedule to the As-Built Schedule.

3.12 SCHEDULE TYPES

A. Preliminary 60-Day Schedule

1. A Preliminary 60-Day Schedule shall be submitted to the Engineer at the Pre-Construction Meeting.
2. Pre-Construction Meeting may be arranged with the Contractor and the Engineer prior to Notice to Proceed (NTP).
3. The Data Date of the Preliminary 60-Day schedule shall be the anticipated date of Notice to Proceed.
4. The Preliminary 60-Day Schedule shall contain a bar chart of activities that will or may affect milestone completion dates including planning, mobilization, coordination, submittals, procurement, fabrication, and construction during first 60 calendar days after Notice to Proceed. It shall also identify activities and milestones that will or may affect or be affected by the activities of others.

B. Baseline Schedule

1. Baseline Schedule is the Contractor's accepted Project Schedule, fully detailed.
2. No later than thirty (30) days from the Notice to Proceed of construction, the Contractor shall submit the proposed Baseline Schedule that fully covers, in-detail, the entire scope and duration of the Project. This schedule shall convey Contractor's plan for organizing, managing, and executing the Work.
3. In order to address for any Baseline resubmittals, Contractor shall not wait for the full 30 calendar days from NTP to submit their initial Baseline Schedule. It is expected that Contractor exercises good judgement in preparation and submission of initial Baseline Schedule as early as possible, but no later than thirty (30) calendar days.
4. Engineer requires fourteen (14) calendar days to review and respond to all schedule submittals (initial and subsequent Baseline Schedule submittals, Progress Status Update Schedule, Schedule Revisions, Fragnets, TIAs).
5. The Data Date of the Baseline Schedule shall be the date of Notice to Proceed.
6. The Baseline Schedule shall contain the Contractor's detailed activities and sequencing for all Work included in this Contract in addition to activities presented in the Preliminary 60-Day Schedule. The Contractor shall assign unique activity identification for each detailed activity.
7. The Baseline Schedule activities shall indicate the Contractor's best estimate for original durations, early dates, late dates, logic ties, constraint dates, and total float. Activities shall be scheduled in the sequence the Contractor intends to perform the Work.
8. The Contractor shall not use any float suppression techniques such as preferential sequencing or logic, special hidden lag time between activities or milestones, float

absorption activities, or unjustifiable over-estimating of activity durations in preparing the Proposed Baseline Schedule.

9. Finish Milestones should be constrained to either a "Finish No Later Than" constraint or a "Finish on or before" constraint. No "Zero Free Float" constraints, no "Early" Constraints, and no "Mandatory Finish" constraints shall be utilized.
10. The Baseline Schedule shall contain the activity sequence for major material and equipment procurement, including submittal preparation, review by the Engineer, fabrication, and delivery. Procurement items that may contain multiple submittals occurring at different times shall be divided into separate activity sequences that can be tracked on an individual basis.
11. Activities shall include the Contract deliverables, such as submittal and approval of permit applications, material samples, shop drawings, working drawings, mock-ups, inspection, test plans, safety and security plans. Activities that may affect progress shall be reflected, as well as those of affected utility companies and other similarly involved third parties. Any such activities set forth in General Conditions or Special Conditions shall be reflected in the Baseline Schedule.
12. The proposed Baseline Schedule shall include start and completion dates for: temporary facilities, construction of mock-ups, prototypes, samples, punch list, interfaces and furnishing of items, separate work contracts, regulatory agency approvals, and permits required for performance of the Work.
13. The proposed Baseline Schedule shall allow for all foreseeable factors and risks which affect performance of the Work. Include allowances for weather conditions in accordance with "Weather", herein, applicable laws, transportation, traffic, air quality, noise, or any other applicable regulatory requirements, regulations or collective bargaining agreements pertaining to labor.
14. Baseline Schedule shall include a schedule basis that defines the premise for the development of the project schedule. It shall assist the project team and stake holders in identifying any key elements, issues and special considerations (assumptions, risks/opportunities, etc.).
15. Once the Baseline Schedule is accepted by the Engineer, it shall become the basis for Progress Status Update Schedules.
16. The Contractor shall, unless directed otherwise by the Engineer, use the Baseline Schedule as one of the targets for required comparisons to the current updates in tabular reports, bar charts, physical progress curves or any other comparisons requested by the Engineer.

C. Monthly Schedule Submittals

1. Progress Status Update
 - a. The Contractor shall make a reflection of the accepted Baseline Schedule. The original accepted Baseline Schedule shall be archived by the Contractor, and the reflection schedule shall be used to prepare the first Progress Status Update.
 - b. The Contractor and Contractor's Scheduler shall attend a month-end Progress Status Update meeting to be held seven (7) calendar days prior to the month-end Data Date. At these meetings, the Contractor must be able to discuss the project status using the scheduling software. This will include actual start and actual finish dates

for activities either in progress or completed, remaining durations of activities in progress.

- c. On a monthly basis, the Progress Status Update Schedule shall be submitted on or before the first working day of each calendar month with the payment application. The Data Date shall be the first day of the following month or as designated by the Engineer.
- d. The schedule shall be progressed to include all work status up to the Data Date. Progress Status Update Schedules shall strictly show the progress achieved during the reporting period. No schedule revisions (including correction of out of sequence work) shall be mixed with schedule Progress Status Update Schedules. Any schedule revisions shall be submitted under a separate schedule.
- e. Progress Status Update Schedules shall be calculated using the "retained logic" option. Corrections to out of sequence Work shall be made per provisions of Article 3.13-C-2, herein.
- f. The Progress Status Update Schedule shall detail progress based on actual start and finish dates for activities completed, and the actual start date and percent of work completed on each activity started but not yet completed.
- g. The Progress Status Update Schedule shall accurately represent the As-Built conditions of all completed Work and percentages remaining of all in-progress activities as of the Data Date of the Schedule.
- h. The Contractor shall respond to all comments or questions from the Engineer's month end review within seven (7) calendar days. The Contractor shall also include these responses in the current Progress Status Update Schedule narrative.
- i. The Progress Status Update Schedule will be subject to rejection and re-submittal if it no longer appears to represent the actual execution of Work.
- j. Submit a narrative report with the Progress Status Update analysis, which shall include, but not be limited to, a description of the problem areas, current and anticipated delaying factors and their impact, an explanation of corrective action taken and any proposed revisions for a Recovery Schedule.
- k. Once the Progress Status Update Schedule is accepted by the Engineer, it shall become the basis for the next Progress Status Update Schedule. The Contractor shall prepare a reflection of the current accepted Progress Status Update Schedule. The original accepted Progress Status Update Schedule shall be archived by the Contractor, and the reflection schedule shall be used to prepare Schedule Revisions or the next month's Progress Status Update Schedule.

2. Schedule Revisions

- a. Contractor shall perform the work in accordance with the Updated Project Status Schedule. However if it no longer appears to represent the actual execution of work, the Contractor needs to provide schedule revisions.
- b. Schedule Revision shall be used if the Contractor needs to modify the order or sequence of accomplishing the Work, or to correct out of sequence work, logic changes, show new or deleted activities, and new change orders.

- c. The Contractor shall obtain the Engineer's approval before making deviations in logic and activity durations between the Progress Status Update Schedule and the Baseline Schedule or between the Progress Status Update Schedule and the Schedule Revisions defined in this Section.
- d. Revisions to schedules shall be submitted separately and must not be part of the Progress Status Update Schedule.
- e. Resolve conflict between actual work progress and schedule logic. When out of sequence activities develop because of actual construction progress, Contractor shall submit revisions to schedule logic to confirm to current job status and directions, without changing activity identification or original durations.
- f. Within the first three (3) days following the submission of the Monthly Progress Status Update, the Contractor shall submit to the Engineer any proposed Schedule Revisions.
- g. The Contractor has the option to provide Schedule Revisions as a separate submittal at the time of submission of the monthly Progress Status Update Schedule. It is emphasized that the Progress Status Update Schedule and Schedule Revisions submittals are separate and cannot be combined into the same submittal file. Progress Status Update Schedule and Schedule Revisions shall be two separate XER submittals.
- h. Revisions to the original duration of any activity, changes in logic, additions or deletion of activities or any other changes of a significant nature require prior written permission of the Engineer.
- i. Any new or changed logic shall be discussed in the schedule narrative and resolved to the satisfaction of the Engineer.
- j. Submit a narrative report with the revised schedule analysis, which shall include, but not be limited to, a description of problem areas, current and anticipated delaying factors and their impact, an explanation of corrective action taken and any proposed revisions.
- k. The Contractor shall submit to the Engineer a Recovery Schedule if the Contractor's Progress Status Update Schedule indicates negative float and there are no pending requests for additional Contract Time.

D. Recovery Schedules

- 1. If the Progress Status Update Schedule or Schedule Revisions show negative float for any stage/phase/region of Work, after incorporating all approved Time Extensions, the Contractor shall submit a Recovery Schedule showing on-time Contract completion.
- 2. The Recovery Schedule shall be based on proposed revisions to construction schedule and shall show how the Contractor intends to bring the Work back on schedule. Recovery Schedules shall also include a written description of how the measures that Contractor intends to take, without additional cost to the City, will regain schedule compliance.
- 3. Schedule recovery, if requested by City to recover time due to delays other than Contractor's, will be negotiated. Any right to reward in these cases is only after all available total float is applied and due diligence efforts required of the Contractor are reviewed and verified to the full satisfaction of the City.

4. Should Contractor fail to submit and execute such Recovery Schedule, the City shall have the option to direct Contractor to employ any or all measures that the Engineer may deem fit to regain schedule compliance without additional cost to the City.
5. Recovery Schedule submitted by Contractor, upon acceptance by the Engineer, shall be incorporated as the current schedule for the next Progress Status Update.
6. Should the Contractor dispute Engineer's determination on Contract delay, such dispute shall not relieve him/her of the responsibility to comply with the requirements of this Section and any other related Sections until the dispute is resolved per Contract terms and conditions.

E. Project Acceleration

1. Contractor shall not assume any constructive acceleration to the Project unless prior written notice is provided by the Contractor to the City expressly stating the facts that any orders for Recovery Schedules or any other actions by the City are being interpreted as an order to accelerate and to which the City provides acknowledgement of said notice in writing.
2. Contractor shall provide any excusable and compensable delay requests within the allowable durations set forth in the Contract Documents. Continued delay in submitting complete and accurate time impact analysis, if any, shall not be treated as an excuse on the Contractor's part to not deliver the Project on time.

F. Look-Ahead Schedules

1. On a weekly basis, the Contractor shall submit from the current Preliminary 60-Day Schedule, Accepted Baseline Schedule, Progress Status Update Schedule or Schedule Revisions, using the approved scheduling software; a Look-Ahead Schedule covering actual work accomplished during previous week and planned work for current and subsequent two weeks. Using other software (i.e. spreadsheets) to produce the Look-Ahead Schedule is not permitted unless approved by the Engineer.
2. The Look-Ahead Schedule shall include activity I.D. numbers and indicate which activities are on the critical path.

G. Revised Baseline Schedule

1. The original Baseline Schedule shall only be revised upon written approval or direction of the Engineer.
2. The Contractor shall, unless directed otherwise by the Engineer, use the Revised Baseline Schedule as the target for required comparisons in tabular reports, bar charts, and cash flow and physical progress curves, or any other comparisons requested by the Engineer.
3. The Contractor shall use the Revised Baseline Schedule for the purposes of subsequent Progress Status Update Schedules once the approved revisions have been made.

H. As-Built Schedule

1. Final As-Built Schedule shall be submitted within thirty (30) calendar days of Substantial Completion of the Contract or by the Affidavit of Final Completion, whichever comes first. The As-Built Schedule specified herein shall be based upon the actual dates and actual durations, as they occurred, to reflect the as-built construction sequence.
2. The As-Built Schedule shall have a Data Date as of the date of Notice to Proceed.

3.13 SCHEDULE REVIEW AND COMPLIANCE

- A. The Engineer's review of the schedule submittals shall not relieve the Contractor from the responsibility for any variations from the requirements of the Contract Documents unless the Contractor has, in writing, called the Engineer's attention to such variations at the time of submission and the Engineer has given written approval of each such variation. Any schedule review and approval by the Engineer shall not in any way relieve the Contractor from the responsibility to comply with provisions of the Contract, except as specifically approved by the Engineer with respect to such specific variation.
- B. If, in the opinion of the Engineer, the schedule (1) does not accurately reflect the Contractor's actual or anticipated progress or work plan or, (2) cannot be used to effectively evaluate the Contractor's progress or, (3) is not in compliance with this Section and other parts of the Contract, it will be returned to the Contractor for corrections and clarification. The Contractor shall make the necessary corrections and resubmit, or shall respond in detail to the Engineer's comments with reasonable explanation why such corrections or clarifications should not be required.
- C. The Contractor shall comply with all of the requirements of this Section. Non-compliance with any of the requirements of this Section will result in one or more of the following:
 - 1. The City will withhold Contractor's monthly payment request for "*Scheduling Activities*" until all deficiencies related to this Section have been corrected to the satisfaction of the City.
 - 2. All monthly Pay Applications shall be accompanied with monthly Progress Status Update Schedules. As such, Pay Applications shall not be considered "properly submitted" unless accompanied by the monthly Progress Status Update Schedule. If accurate schedule submittals are not provided with Pay Applications, City may withhold payment, in whole or in part. The City will hire an independent scheduler and deduct the cost of the scheduler from the Contractor's progress payments.

PART 4 MEASUREMENT AND PAYMENT

- A. Measurement for "*Network Analysis and Project Schedules*" shall be a percentage of the Lump Sum bid for this item. Twenty-five percent (25%) of the Bid amount will be paid upon Engineer's approval of Baseline Schedule. The remaining seventy-five (75%) of the Bid amount will be divided into equal installments, to be paid each month of the Contract duration for satisfactory implementation of the approved Progress Status Update Schedules, at the discretion of the Engineer. Payment shall constitute full compensation for preparing and providing all labor, materials, equipment, and incidentals required to provide and maintain Project Schedules as described in this Section.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

Contractor shall prepare, review, and provide submittals, including plans, procedures, certificates, shop drawings, product data, samples, and miscellaneous work-related submittals. Individual requirements for submittals are described in pertinent Sections of these Specifications. Contractor shall use the City's Construction Management Software (CMS) system for submittals.

1.02 TYPES OF SUBMITTALS

Submittals are categorized for convenience as follows:

1. Product Data include standard published information on materials, products and systems such as catalogues, brochures, Safety Data Sheets, etc.
2. Shop Drawings include drawings, diagrams, performance curves, technical data, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and similar information.
3. Samples include physical examples of materials either for limited visual inspection or for more detailed testing and analysis (where indicated).
4. Operation and Maintenance Submittals include manuals (both digital and physical copies), training videos, maintenance agreements, and similar information.
5. Warranty Submittals include warranties, workmanship bonds on materials, products and systems. Warranties can be made by the manufacturer, vendor, and/or Contractor.
6. Miscellaneous Submittals include submittals related directly to work (non-administrative) such as daily logs, permits, survey data and reports, field measurement data, and copies of industry standards.
7. Design Submittals include calculations, reports, measurements, drawings, diagrams, performance curves, and reference technical data prepared specifically for the materials, products or systems as installed for this project.
8. Administration Submittals include contact lists, schedules, qualifications, work plans and procedures, phasing plans, physical work records, as-built records and drawings, and similar information.
9. Testing Submittals include test reports, tickets, and certificates of compliance demonstrating compliance with materials, tests or specifications indicated.

1.03 SCHEDULE OF SUBMITTALS

- A. Prior to start of any work, and within ten (10) calendar days after the date of Notice to Proceed, identify submittals that will be required in each Specifications Section and determine date on which submittal will be made, coordinated with the baseline construction schedule and allowing

the City reasonable time to review. Submittal schedule shall be submitted with Contractor's schedule to Engineer for approval in accordance with Section 01 31 19, "PROJECT MEETINGS" and Section 01 32 16, "NETWORK ANALYSIS AND PROJECT SCHEDULES", and to be incorporated into the CMS. No work shall commence at Work Site until these schedules are submitted and approved. Submittals of components that are required for a total system submittal shall be identified on the submittal schedule. Contractor shall be solely responsible for any delay, disruption, impact, loss of efficiency or other loss, arising directly or indirectly from Contractor's failure to manage Submittals properly. Contractor's complete and timely submission of Submittals in conformity with the Submittal Schedule is a material consideration of the Contract.

1.04 GENERAL SUBMITTAL REQUIREMENTS

- A. Product submittals shall be submitted within 30 days of Notice to Proceed.
 - 1. Early submission of Long Lead Items: within 15 days after Notice to Proceed
 - a. 14 47 00 "WORKSTATION CRANE"
 - b. 11 11 05 "SHOP SERVICE EQUIPMENT; WORK BENCHES"
- B. Submittal documents prepared by or on behalf of Contractor shall comply with the design and performance criteria for such Work set forth in these Technical Specifications. Where required for items requiring design by the Contractor, the Contractor shall submit documents provided by a properly licensed design professional, who shall comply with the reasonable requirements of the City regarding qualifications and whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other documents prepared by such professional. Submittals related to the Work designed or certified by such professionals shall bear professional's written approval when submitted to the City. The City shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals. The City will review, accept, or take other appropriate action on such submittals only for the limited purpose of checking for conformance with the design and performance criteria set forth in these Technical Specifications.
- C. In the event that the City reasonably determines that all or any portion of any Submittal fails to comply with the requirements of the Contract Documents and/or such Submittals are not otherwise complete and accurate so as to require re-submission more than one (1) time, Contractor shall bear all costs (within the Contract Price) associated with the review and acceptance of such resubmitted Submittals. No adjustment to the Contract Time or the Contract Price shall be granted by the City to the Contractor on account of its failure to make timely submission of any Submittals.
- D. At preconstruction meeting, Engineer and Contractor shall discuss exact procedure to be adopted for processing of submittals. Unless otherwise approved by Engineer in writing, submittals shall be made by the Contractor at time indicated on Contractor's approved submittal schedule. Engineer will make every effort to process and respond to submittals within fourteen (14) calendar days after receipt from Contractor. If additional processing time is required, Engineer will notify Contractor in writing.
- E. Submittals shall be made for a complete system. Submittals of individual components of a system, or piecemealed submittals, will be considered incomplete and will be returned "Rejected". No extension of time shall be given for any re-submittal for approval due to incomplete submittals.

- F. No portion of the work requiring submission of a shop drawing, product data, or sample shall commence until the submittal has been approved by the Engineer. All such portions of the work shall be in accordance with approved submittals. No extension of time shall be given for any re-submittal for approval by the Engineer.
- G. Before making submittals, ensure that products will be available in quantities and in time required by Contract.
- H. Coordinate and sequence different categories of submittals for interface units of work so that one will not be delayed for coordination with another.
- I. If access to the CMS is not readily available at the Work Site, the Contractor shall maintain a file of all approved submittal documents at the Work Site.
- J. Furnish permanent marking on each submittal to identify project, date, Contractor, subcontractor, submittal name and similar information to distinguish it from other submittals. Include the following:
 - 1. Submittal document identifier number corresponding to the CMS.
 - 2. Respective Contract Drawing numbers.
- K. Clearly identify all approved deviations from Contract Drawings and Specifications, including or-equal substitutions, and references to the written approval(s) from Engineer.
- L. Show executed internal review and approval marking. Submittals which are received from sources other than through Contractor's office or which have not undergone Contractor review will be returned "Rejected".
- M. Deliver submittals in properly specified format for each submittal category. Failure to follow this direction shall not relieve Contractor from compliance with Contract cost and schedule.
- N. Non-electronic format will be accepted for sample submittals and mock-ups, which must be received by the Engineer on the same day or before the submittal record is made in the CMS.
- O. Final operations and maintenance manuals shall be provided in electronic searchable PDF format via the CMS. Additionally, provide (3) USB flash drives.
- P. Except as otherwise indicated more stringently in individual Technical Specification Sections, Contractor shall comply with requirements specified herein for each indicated category of submittal.

1.05 WORK PLANS AND PROCEDURES

- A. Submit a work plan for major work as indicated in each Technical Specifications Section and on the Contract Drawings. Each plan shall include narrative descriptions, drawings and diagrams, lists, and any other necessary information to identify the responsible party, and identify all Contractor procedures and products used to satisfy Contract requirements.
- B. The work plan shall summarize the Contractor construction activities and furnish sufficient detail to allow the Engineer to establish inspection and test responsibilities. The activities shall match activities as listed on the project schedule.
- C. Coordinate the schedule of all activities defined in the work plan seven (7) calendar days prior to commencing work and furnish a status update of all activities during the weekly progress meeting.

- D. The work plans will be reviewed only for general conformance with the Specifications and will be used for project coordination between Contractor, Engineer and City tenants

1.06 CERTIFICATES OF COMPLIANCE

- A. Submit Certificates of Compliance to Engineer for materials, products and systems installed. The certificates shall:
 - 1. State that product complies with respective Contract Specification and Contract Drawing requirements.
 - 2. Be accompanied by a certified copy of test results pertaining to product. All test equipment used shall be verified to be in calibration at time of each test and test reports shall so indicate. No test shall be made without such verification. When specified in the pertinent Technical Specification Section, certified test results shall be sealed by a Professional Engineer licensed to practice in the State of California.
 - 3. Show product represented and its location in Contract, producer's name, product trade name and catalog number as applicable, place of product origin; test date, testing organization's name and address, quantity of product to be furnished, and related Contract Drawing and Specification section numbers.

1.07 SHOP DRAWINGS

- A. Shop drawings shall be submitted via the CMS.
- B. Where a submission involves engineering computations or original design work is depicted, submission shall show name, State of California registration number, seal and signature of Professional Engineer licensed in the discipline required for the work and certifying that computations and/or design work are correct and in conformance with standards, codes and acceptable engineering practice.

1.08 PRODUCT DATA

- A. Furnish manufacturer's literature for all equipment, products, specialties, manufactured items and items required by pertinent sections of these Specifications.
- B. Collect required data into one submittal for each unit of work or system, and mark each copy to show which choices and options are applicable to the project.
- C. Include the manufacturer's standard recommendations for application and use, compliance with standards, notation of field measurements which have been checked, and special coordination requirements.
- D. Highlight manufacturer's standard(s) diagrams, schedules, performance charts, illustrations, calculations, and other descriptive data to show information which is applicable to Contract.
- E. Indicate dimensions, clearance, performance characteristics, capacities and any other diagrams, as applicable.

1.09 SAMPLES

- A. Samples may be submitted in non-electronic format, but must have a submittal record with photograph(s) in the CMS for tracking purposes.

- B. Furnish samples identified with final condition of proposed materials or products for work. Include "range" samples (not less than three units) where unavoidable variations must be expected.
- C. Include information with each sample where so indicated with each sample to show generic description, source or product name, manufacturer, and compliance with standards and specifications.
- D. Samples are submitted for review and confirmation by Engineer. Engineer will not "test" samples (except as otherwise indicated) for compliance with Specifications. Contractor shall have exclusive responsibility of demonstrating material compliance.

1.10 GENERAL DISTRIBUTION

Furnish additional distribution of approved submittals to subcontractors, suppliers, fabricators, installers, governing authorities and others as necessary for proper performance of work.

1.11 REVIEW OF SUBMITTALS

Engineer will review submittals for general conformance with design concept only or for review only. Review by Engineer shall not relieve Contractor or any Subcontractor of responsibility for full compliance with Contract requirements; for proper design of details; for proper fabrication and construction techniques; for proper coordination with other trades; and for furnishing all devices required for safe satisfactory construction and operation.

1.12 SUBMITTAL STATUS

- A. Submittals reviewed by Engineer and returned to Contractor will be marked with one of the following designations:
 - 1. No Exceptions Taken.
 - 2. Make Corrections Noted.
 - 3. Revise and Resubmit.
 - 4. Rejected.
 - 5. Submit Specified Item.
 - 6. For Reference Only.
- B. Do not proceed with procurement, manufacture or fabrication of items submitted for review until such submittals have been designated by Engineer as "No Exceptions Taken" or "Make Corrections Noted". Failure by Contractor to receive timely submittal approval shall not relieve Contractor from conforming to Contract cost or schedule.

1.13 SUBMITTALS DESIGNATED AS "NO EXCEPTIONS TAKEN" OR "MAKE CORRECTIONS NOTED"

- A. Submittals designated by Engineer as "No Exceptions Taken" or "Make Corrections Noted" will be identified accordingly by being stamped and dated.
- B. When a submittal has been designated as "No Exceptions Taken" by Engineer, construction shall be carried out by Contractor in accordance therewith and no further changes made therein, except upon written instructions from Engineer.

- C. When a submittal has been designated as "Make Corrections Noted" by Engineer, Contractor shall revise the submittal according to the marked changes and carry out construction in accordance with the revised submittal and with no further changes except upon written instructions from Engineer. Contractor shall submit a revised submittal for record purposes and shall proceed with the work as scheduled.
- D. Contractor shall take responsibility for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of work prior to being marked "No Exceptions Taken" or "Make Corrections Noted" by Engineer.
- E. When submittals are stamped "Make Corrections Noted" the Contractor shall only be permitted to make the marked corrections before implementing the submitted item.

1.14 SUBMITTALS TO BE RESUBMITTED

- A. If submittals require corrections that require further review and approval, those submittals will be designated "Rejected", "Revise and Resubmit", or "Submit Specified Item". Contractor shall make indicated changes and resubmit for review and approval by Engineer.
- B. When a submittal has been designated as "Revise and Resubmit" by Engineer, Contractor shall make indicated changes to submittal package, materials selected, material properties, products, or systems and submit revised submittal for review.
- C. When a submittal has been designated as "Submit Specified Item" by Engineer, Contractor shall submit additional items and information requested by Engineer. Other parts of the submittal are considered approved and do not need to be resubmitted; however, work shall not proceed until the additional items or information is submitted, reviewed, and approved by Engineer.
- D. When a submittal has been designated as "Rejected" by Engineer, the material, product, system, or work plan is considered unacceptable as a whole. Contractor shall submit information to replace the unacceptable material, product, system, or work plan.
- E. Resubmissions will be handled in same manner as first submissions. Direct specific attention, in writing or on the submittals, to revisions other than corrections requested by Engineer on previous submittals.
- F. Contractor shall notify Engineer prior to execution of any correction indicated on submittals, which constitutes a change of Contract requirements.

1.15 SUBSTITUTIONS

- A. Substitutions shall be made in accordance with General Conditions GC-3.4.7, "Or Equal Substitution of Equivalent Materials, Products or Equipment".

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other Work shall be considered incidental.

END OF SECTION

SECTION 01 35 23

OWNER SAFETY REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

The work specified in this Section consists of utilizing safety equipment and safety aids on construction equipment and assuring safe operations for the duration of the Work, as specified and shown.

Compliance with requirements of this Section shall not relieve the Contractor from other obligations imposed elsewhere in the Contract Documents, by law and by regulation.

1.02 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES", and shall include Contract-specific Site Specific Safety Plan (SSSP) prepared in accordance with the General Conditions Section 3.31, and all relevant safety information and programs, including:

- A. Hazard Evaluation – Include job hazard assessments (JHAs) to identify potential hazards associated with the work activities. Identify the tasks associated with the work activities, list the hazards associated with the tasks, and provide the steps that will be taken to mitigate the hazards, including procedures and PPE requirements. Refer to APPENDIX M for specific Submittal requirements.
- B. Should site conditions require work to be performed under HazWoper conditions, Contractor shall submit a Health and Safety Plan (HASP) including but not limited to the following information:
 - 1. Organizational Structure
 - 2. Safety and Health Assessment/Analysis
 - 3. Exposure and Environmental Air Monitoring
 - 4. Controlling Fugitive Dust Emissions
 - 5. Training Requirements including records
 - 6. Medical Surveillance
 - 7. PPE requirements including conditions for upgrading or downgrading PPE
 - 8. Site Control/Work Zone
- C. Crane Lift Plan – Submit a Crane Lift Plan for any lift considered a "Critical Lift". A "Critical Lift" shall be defined as any non-routine crane lift requiring detailed planning and additional or unusual safety precautions. Critical lifts include: lifts made when the load weight is greater than 75% of the rated capacity of the crane; lifts which require the load to be lifted, swung or placed out of the operator's view; lifts made with more than one crane; lifts involving non-

routine/technically difficult rigging arrangement; hoisting personnel with a crane or derrick; lifts involving materials or equipment that are considered critical to the completion of the project or whose value is \$50,000 or greater; lifts when the placement of the crane or boom radius is limited or requires extra precautions; or any lift which the crane operator believes should be critical.

Crane Lift Plans shall be submitted to the City at least 5 business days prior to the date of lift. Plans shall be reviewed and accepted by the City prior to lift. Crane Lift Plans shall include but are not limited to:

1. Total Load Weight – Include auxiliary and main blocks, lifting beams, slings/shackles, jib, and hoist rope.
 2. Crane Lift Information – Include crane type, crane capacity, its radius and boom length, boom angle, and percentage of lift weight to load capacity.
 3. Rigging – Description of rigging method including the hitch type and number of slings and shackles.
 4. Crane Placement – Provide the maximum bearing pressure, including pressure calculations, and area hazards.
 5. Qualifications – Provide Certifications/Qualifications for Crane Operators and Riggers.
 6. Lift Restrictions – Describe any limiting factors affecting the lift such as wind speed and precipitation.
 7. Site Plan and Load Calculations
- D. Fall Protection – Contractor's Fall Protection Program and a Site Specific Fall Protection Work Plan shall be submitted to the City for review when the project exposes the Contractor to heights of six feet (6') or greater. The Site Specific Fall Protection Work Plan shall include, but is not limited to the following information:
1. Fall Hazards – A description and location of the fall hazard, including the type of work being performed in proximity to the fall hazard.
 2. Control Method – A description of the method the Contractor will use to protect employees from fall hazards.
 3. Equipment – Type of equipment and tools utilized and the procedures for handling, storage, and securing such tools and equipment.
 4. Rescue Procedure – Method used to ensure prompt rescue in the event of a fall.
 5. Training Records
 6. Communication – Method used to ensure communication with fall protection equipment users and ability to contact emergency responders.
- E. Excavation/Trench – Before constructing any trench or excavation 5 feet or more in depth when the project requires the Contractor to enter excavations and trenches, the Contractor shall submit an Excavation/Trench Program and a Site Specific Excavation/Trench Work Plan. Depending on work conditions/operations of the excavation/trench, the space may be deemed a confined space and/or a fall hazard. Contractor shall be responsible for the evaluation of the

work site and the establishment of mitigating procedures for all hazards associated with the excavation/trench. The Site-Specific Excavation/Trench Work Plan shall include, but is not limited to the following information

1. A valid Excavation permit from the California Department of Industrial Relations.
2. The name(s) and training records of the on-site competent person(s). A competent person must be on-site during all trenching or excavation work.
3. The protective measures that the Contractor will use to comply with Title 8, California Code of Regulations, Sections 1539 through 1543. Include the following elements:
 - The locations of excavations/trenches,
 - The estimated length, width and depth of each excavation/trench,
 - The protective measures that will be used (i.e. sloping, shoring or shielding) to prevent cave-in for each excavation/trench. If shoring or shielding will be used the Contractor must submit the tabulated data for the equipment that will be used,
 - The method that will be used to prevent unauthorized workers from entering the excavation/trench,
 - Equipment or activities nearby or in the trench/excavation that may affect atmospheric conditions. Provide mitigation procedures if applicable,
 - The method that will be used to protect workers who are required to work adjacent to the excavation/trench from falling into the excavation/trench,
 - The method that will be used to enter and exit the excavation/trench, and
 - A copy of the Contractors excavation/trench competent person inspection checklist.

If the protective measures detailed in the plan varies from the standard practices established by the Cal/OSHA construction safety orders or if the trenches/excavations are greater than 20 feet deep, the plans shall be prepared by a California registered civil or structural engineer employed by the Contractor and all costs therefore shall be included in the price named in the contract for completion of the Work as set forth in the Contract Documents. Nothing in this section shall be construed to impose tort liability on the City, or any of its officers, agents, Construction Managers or employees.

The majority of soil at the Port is considered type C soil as defined by the Cal/OSHA excavation standard. Contractors shall assume that all soils at the Port are type C unless the Contractor's competent person can prove otherwise through the use of approved soil classification methods as described in the Cal/OSHA excavation standard.

The Contractor shall document in writing the daily trench/excavation inspections and shall make these inspections available to the City upon request.

- F. Electrical Systems – Contractor's Electrical Safety Program and a Site Specific Energized Electrical Work Procedure shall be submitted to the City for review when the project requires the Contractor to work on electrical systems. The Site Specific Energized Electrical Work Procedure shall include, but is not limited to the following information:

1. Electrical System Description – Provide equipment information and location.

2. Work Condition – Description of whether the system will be isolated or worked on while energized.
 - a. If de-energized:
 - Lockout/Tagout (LOTO) Program
 - Specific LOTO procedures
 - b. If energized:
 - Estimated voltage and amperage of systems
 - Hazard Risk Category
 - PPE requirements
 - Work Zone Protection
3. Training Records – Include First Aid/CPR training documentation in addition to NFPA 70E training records
- G. Lockout/Tagout (LOTO) – Contractor's LOTO Program and a Site Specific LOTO Work Procedure shall be submitted to the City for review when the project requires the Contractor to work on energized systems other than electrical (e.g. gas, oil, water, etc.). The Site Specific LOTO Work Procedure shall include, but is not limited to the following information:
 1. Equipment Description – Provide equipment information and location.
 2. Lockout Procedures
 3. Diagrams – For multiple energy sources
 4. Training Records
- H. Crystalline Silica – Contractor's Silica Exposure Control Plan (SECP) shall be submitted to the City for review when the project requires the Contractor to disturb concrete or masonry materials as defined by Cal/OSHA (8CCR 1530.1). The SECP shall include, but is not limited to the following information:
 1. Description – Describe the crystalline silica containing materials that will be disturbed or abated, including volume and locations, and a description of specific tasks disturbing silica containing materials and equipment utilized.
 2. Exposure Control – Describe the engineering controls, work practices, and/or respiratory protection used to limit employee exposure to respirable crystalline silica for each task.
 3. Worksite Control – Describe the housekeeping measures and procedures to restrict access to work areas, when necessary, to minimize the number of employees exposed to respirable crystalline silica.
 4. Exposure Monitoring – Describe the method of exposure assessment for employees who are or may reasonably be expected to be exposed to respirable crystalline silica at or above the action level.

5. Respiratory Program (If applicable)
6. Training Records
7. Medical Surveillance (If applicable) – Including respiratory fit testing records.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 GENERAL

- A. Unless otherwise noted in Part 1.03 above, all safety submittals shall be provided to the City for review at least 10 calendar days prior to the intended work activity.
- B. The Contractor shall not be allowed to proceed with Site Work until all Engineers' comments on the safety submittals have been addressed in writing by the Contractor, and the writing addressing the Engineers' comments have been transmitted to the City.
- C. If requested by the Engineer, prepare and submit updates to all safety plans and site safety practices to adhere to any public health emergencies and regulations.
- D. Submittals, particularly site- or activity-specific submittals, shall be updated as necessary to reflect changes in worksite conditions, work activity, the Contractor's means, methods, techniques, sequence of work, work procedures, or scope of work. Updated submittals shall be provided to the Engineer for review prior to implementation. A copy of all submittals shall be maintained at the Work Site at all times.
- E. The Contractor shall be responsible for following procedures, setting up the work area, completing safety forms, investigating all incidents and injuries, and utilizing equipment as stated in the submittals accepted by the City. Any deviation from the accepted submittals shall require a submittal revision be provided to and reviewed by the City.
- F. The Contractor shall be fully responsible for subcontractors' compliance with safety submittals accepted by the City. A subcontractor requesting deviation from the Contractor's safety submittals shall provide their own safety submittal compliant with the specifications required of the Contractor. Any requested deviation requested by the subcontractor must be considered, in standard industry practices, to be as safe as or safer than the Contractor's submission.
- G. The Contractor shall be responsible for the dissemination of submitted safety materials and any subsequent revisions to all affected parties and individuals that will be on the Work Site.

PART 4 – MEASUREMENT AND PAYMENT

- A. Measurement for "*Owner Safety Requirements*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. The initial fifty percent (50%) of the lump sum provided in the Schedule of Bid Items will be paid upon approval of the SSSP submittal by the Engineer. Remaining fifty percent (50%) shall be paid in equal monthly payments over the duration of the Contract. Payment shall include furnishing all transportation, labor, materials, equipment, and incidentals necessary to furnish, operate, maintain, and utilize safety equipment and safety aids on construction equipment and

ensure safe operations around the entire work area as specified, shown, and required by applicable laws.

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Requirements for Contractor to provide quality-assurance and quality-control services required by the Engineer, the City, or authorities having jurisdiction are not limited by provisions of this Section.

1.02 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- E. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- F. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- G. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and

completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by the Engineer.

1.03 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Engineer.
- B. Delegated Design Services Statement: Submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.04 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to the Engineer for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Engineer for a decision before proceeding.

1.05 SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Permits, Licenses, and Certificates: For the City's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.06 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - 1. Statement on condition of substrates and their acceptability for installation of product.
 - 2. Statement that products at Project site comply with requirements.
 - 3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 5. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
 - 1. Statement that equipment complies with requirements.
 - 2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 3. Other required items indicated in individual Specification Sections.

1.07 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.08 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 1. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor will not employ same entity engaged by the City, unless agreed to in writing by the City.
 - 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 - 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - 4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- C. Testing Agency Responsibilities: Cooperate with the Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 1. Notify the Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "SUBMITTAL PROCEDURES."
- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- F. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 6. Security and protection for samples and for testing and inspection equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to the Engineer.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for the Engineer's authorities' having jurisdiction reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.02 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 70 00 "EXECUTION AND CLOSEOUT REQUIREMENTS."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

PART 4 - MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 – GENERAL

1.01 SUMMARY

- A. The Work specified in this Section consists of providing temporary facilities for construction, as specified and shown, including but not limited to the following:
1. Contractor's field office and storage buildings and their utility service at the Work Site.
 2. Temporary electricity.
 3. Temporary lighting of the Work Site.
 4. Temporary sanitary facilities.
 5. Telephone service.
 6. Temporary water.
 7. Temporary security.
 8. Temporary fire protection.
 9. Temporary work.
 10. First aid facilities.
 11. Trash facilities and service during construction.
 12. Contractor's field office and storage buildings and their utility service at the Work Site.

1.02 REFERENCES

Comply with provisions of all local, State, and Federal codes, specifications, standards and recommended practices, except as otherwise indicated and, in particular, of most recent English measurement edition, unless otherwise noted, and addenda thereto of:

1. National Fire Protection Association (NFPA)
2. National Electrical Code (NEC)
3. City of Long Beach Standard Plans and City of Los Angeles Standard Plans

PART 2 – PRODUCTS

2.01 GENERAL

Temporary construction materials may be new or used, but shall be adequate in capacity for required usage, shall not create unsafe conditions, and shall not violate requirements of applicable codes and standards.

2.02 TEMPORARY FIELD BUILDINGS

- A. Provide, permit, and pay for field buildings adequate in size and accommodation for Contractor's offices, supply, and storage at the Work Site.
- B. Electricity, telecommunications, and water service points for the Work Site field office and storage buildings will be available as shown on the Contract Drawings.
- C. The Contractor shall make all connections to existing power, telecommunications, and water service at the Contractor's own expense in a manner approved by the Engineer, and the Contractor shall pay all usage fees for said services.

2.03 TEMPORARY ELECTRICITY AND LIGHTING

- A. Provide and obtain permits for all electrical power necessary to accomplish the Work. Provide necessary distribution circuits for its use.
- B. The construction power system at the Work Site shall conform to the current codes, regulations, and permitting conditions as specified in NEC, CAL/OSHA, City of Long Beach, LADWP and the City of Los Angeles.
- C. The construction power system at the Work Site shall conform to the current codes, regulations, and permitting conditions as specified in NEC, CAL/OSHA, SCE and the City.
- D. Temporary light and power systems shall be installed and routed in a manner acceptable to the Engineer.
- E. Temporary lighting of the Work Site shall be sufficient to enable Contractor to complete the Work and to enable the Engineer to inspect the Work as it is being done. Illumination shall meet or exceed State code requirements.
- F. Provide temporary service for power and lighting of temporary field buildings.
- G. Temporary electrical service and lighting for the MPE and Treatment System, Temporary Parking Lot, Temporary Facilities shall be in accordance with Division 26.
- H. Requirements
 - 1. Furnish, install, maintain, and remove temporary electrical service facilities, of capacities and at locations approved by the Engineer.
 - 2. Facilities exposed to weather shall be weatherproof type and electrical equipment enclosures shall be locked to prevent access by unauthorized personnel.
 - 3. Provide installation of temporary services.
 - 4. Patch affected surfaces and structures after temporary services have been removed.
 - 5. Extend services from temporary main service switches and provide lighting fixtures, initial and replacement lamps, and maintenance thereof.
 - 6. Provide lamps, wiring, switches, sockets, and similar equipment required for temporary Work Site lighting and for power tools.

2.04 TEMPORARY WATER

Obtain temporary water as specified in General Conditions GC-3.4.2.1.

2.05 TRASH RECEPTACLES

- A. Trash receptacles Trash receptacle shall be with lid.

PART 3 - EXECUTION

3.01 GENERAL

- A. Establish and maintain field buildings and equipment laydown and storage area at the Work Site for the purpose of administering the work throughout the Contract period.

- B. All project documentation, drawings, inspection reports, correspondence, etc., shall be maintained at the Contractor's field office at the Work Site in a location readily accessible to the Engineer.
- C. Modify and extend facilities as work progress requires.

3.02 ENCLOSURES, FENCING AND BARRICADES

- A. Provide and maintain for the duration of the work all scaffolds, tarpaulins, canopies, fans, filters, warning signs, steps, platforms, bridges and other temporary construction necessary for proper completion of the work in compliance with pertinent safety and other regulations.
- B. Provide and maintain fencing and lockable gates as required to maintain security of the Work Site boundaries in accordance with the latest revision of Port of Long Beach Std. Plan No. ST-19 and Appendix V.
- C. Provide barricades to vehicles and pedestrians as required to maintain pedestrian and vehicular traffic flow.
- D. Provide temporary chain link fencing at a minimum of 8-feet in height as required for protection of facilities to remain in place. If fence is to remain in place for more than three (3) months the fence shall be constructed, with post foundations, in accordance with the latest revision of Port of Long Beach Std. Plan No. ST-19 and Appendix V.

3.03 REMOVAL

- A. Completely remove temporary facilities, materials, and equipment when their use is no longer required.
- B. Clean and repair damage caused by temporary installations or use of temporary facilities.

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

Contractor shall perform project closeout in compliance with the administrative and procedural requirements, as specified and shown, including the following:

- A. Final cleaning.
- B. Furnish complete and clearly marked redline Drawing and Specification Record Documents for Engineer's approval.

Additional closeout requirements for specific construction activities are included in the applicable Technical Specifications.

1.02 SUBMITTALS

Prior to request for the final payment, submit the final Record Documents via the Construction Management Software (CMS) specified in the Special Conditions, and secure Engineer's approval. The following items shall be submitted, per the requirements specified in General Conditions GC-9.9:

- A. full size .pdf of the redline Drawings;
- B. all CAD files in AutoCAD format including all references and attachments;
- C. .pdf of all redline Specifications and other marked Record Documents.
- D. .pdf of all warranties, Operation and Maintenance Manuals, and other items specified within pertinent Sections of these Technical Specifications, and as specified in the General Conditions.

1.03 QUALITY ASSURANCE

- A. Accuracy of Records: Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other documents where such entry is required to properly show the change. Accuracy of records shall be such that future searches for items shown in the Contract Documents may reasonably rely on information obtained from the approved Record Documents.
- B. Entries shall be made in .pdf or AutoCAD within twenty-four (24) hours after receipt of information.
- C. The Engineer's review of the current status of Record Documents will be a prerequisite to the Engineer's approval of requests for progress payment and Engineer's approval for request for final payment under the Contract.
- D. Prior to submitting each request for progress payment, secure the Engineer's review of the Record Documents as currently maintained.

PART 2 – PRODUCTS

2.01 RECORD DOCUMENTS

- A. The Engineer will provide a Conformed set of Contract Documents in electronic format to the Contractor at the Preconstruction Meeting. Contractor shall be responsible for any printing, copying, or scanning necessary for the Work and for producing, maintaining, and submitting via the CMS all Record Documents.
- B. Use all means necessary to maintain the redline Drawings and Specifications at the Work site, completely protected from deterioration and from loss and damage until completion of the Work. In the event of loss of recorded data, use all means necessary to secure the data for the Engineer's approval; such means shall include, if necessary in the opinion of the Engineer, removal and replacement of concealing materials and, in such case, all replacements shall be to the standards originally specified in the Contract Documents.

PART 3 – EXECUTION

3.01 MAINTENANCE OF REDLINE DRAWINGS AND SPECIFICATIONS

- A. Identification: Contractor shall identify each of the Documents with the title "Record Documents – Job Set" in red.
- B. Making Entries on Drawings: Contractor shall use red markings in pdf or AutoCAD to clearly describe the change by note and by graphic line, as required. Date all entries. Call attention to the entry by a "cloud" around the area or areas affected. Reference the change to the RFI, Change Order, or other directive as appropriate, in addition to the following:
 - 1. If an entry is later revised, line through the original entry with a single line to maintain a record of all changes and add the revised entry.
 - 2. Make all entries clear and legible using the same drafting standards used for the original drawing.
 - 3. Additional full-sized sheets may need to be added to the redline Drawings to properly convey changes, if crowding due to the number of changes becomes a problem.
- C. Making Entries on Specifications or other documents: Clearly indicate any changes to the Specifications or other Contract Documents, including inadvertent errors by the Contractor which have been accepted by the Engineer, by note in red in the pdf.
- D. Conversion of Schematic Layouts:
 - 1. In most cases on the Contract Drawings, arrangement of conduits and circuits, piping, ducts, and other similar items, is shown schematically and is not intended to portray precise physical layout. Final physical arrangement is as determined by the Contractor, subject to the Engineer's approval. However, design of future modifications of the facility may require accurate information as to the final physical arrangement of items which are shown only schematically on the Contract Drawings. All such final placement shall be recorded in the redline Drawings.
 - 2. Show on the redline Drawings, by dimension accurate to within one inch, the centerline of each underground run and aboveground concealed items. Clearly identify the item by accurate note such as "electrical duct bank", "water", etc. Show, by symbol or note, the

vertical location of the item. Make all identification sufficiently descriptive that it may be related reliably to the Specifications.

3.02 APPROVAL OF RECORD DOCUMENTS

At completion of the Work, submit the completed electronic redline Drawings, Specifications, manuals, warranties, and other marked documents, as necessary, via the CMS for Engineer's review and approval. Make any necessary changes noted during that review and resubmit the final set of documents.

3.03 WARRANTIES

For partial occupancy, submit written warranties upon request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated. Submit properly executed warranties within 15 calendar days of completion of designated portions of the Work that are completed and occupied or used by Engineer during construction period by separate agreement with Contractor. All warranties shall be submitted electronically via the CMS.

3.04 FINAL CLEANING

- A. General: Provide final cleaning and conduct cleaning and waste-removal operations to comply with local laws and ordinances, and Federal and local environmental and antipollution regulations.
- B. Cleaning:
 - 1. Employ experienced workers or professional cleaners for final cleaning.
 - 2. Clean surfaces for Engineer's approval.
 - 3. Comply with safety standards for cleaning.
 - 4. Complete the following cleaning operations before requesting inspection for Substantial Completion for the Work or for a phase/ portion of the Project:
 - i. Remove tools, construction equipment, machinery, and surplus material from the Work site.
 - ii. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances.
 - iii. Do not disturb natural weathering of exterior surfaces.
 - iv. Restore reflective surfaces to their original condition.
 - v. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, maintenance holes, and other similar spaces.
 - vi. Remove labels that are not permanent.
 - vii. Repair and restore marred, exposed finishes and surfaces.
 - viii. Remove all graffiti or other forms of vandalisms on all improvements covered by the Work, including new graffiti or other forms of vandalisms on existing improvements the Contractor is responsible to protect.
 - ix. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

- x. Replace parts subject to unusual operating conditions.
 - xi. Leave Work site clean and ready for occupancy.
- 5. Waste Materials and Disposal: Remove waste materials from Work site and dispose of lawfully.

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 01 71 13

MOBILIZATION

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes outline of the work of mobilization for the project.
- B. Work Not Included:
 - 1. Items which are not to be included in mobilization are:
 - a. Any portion of the Work covered by a specific bid item or incidental work which is to be included in a bid item or items.
 - b. Profit, interest on bond money, overhead, or management costs which is considered incidental to the work.

1.02 DEFINITIONS

- A. Mobilization: Operations necessary for movement of personnel, equipment, supplies and incidentals to work site; for establishment of all temporary offices, buildings and other facilities necessary for work on project; and for all other work and operations which must be performed or are incidental to beginning work including all temporary utility connections.
 - 1. Work for mobilization as specified in this Section consists of pre-construction expenses and activities for preparatory work and operations performed at the start of the Contract work and removal of work.
- B. Demobilization: Removal of personnel, equipment, supplies, property of the Contractor's employees and all subcontractors, suppliers, and their employees, and incidentals from work site, Contractor-owned structures, facilities, materials and debris; and for all other work and operations which must be performed or are incidental to completion of work of various contract items. Comply with the requirements specified in General Conditions Articles 3 and 9.

1.03 SUBMITTALS

Pre-construction Survey Report: Include environmental conditions of concern that differ from those indicated in the Contract Documents.

- 1. Provide a schedule of mobilization activities including the establishment of temporary utilities, contractor site offices, traffic control measures, and all other elements of work which are part of mobilization.
- 2. Provide a plan showing the relationship of temporary facilities to existing conditions and the planned work. Include lay-down areas, vehicle pathways, safety buffer zones, utility corridors and other components of temporary facilities which will require dedicated space on the site.

1.04 DELIVERY, STORAGE AND HANDLING

Delivery to the work site of construction tools, equipment, materials and supplies shall be accomplished in conformance with local governing regulations.

1.05 PROJECT CONDITIONS

Pre-construction Survey: Prior to mobilizing on-site, perform a pre-construction survey of the Project site and prepare a Pre-construction Survey Report for submittal to the Engineer. Photograph existing conditions in, and adjacent to the Site, including existing items to remain during construction, from different vantage points, as directed by Engineer.

1. Prepare and submit a report documenting the observed conditions and specifically identifying any conditions that differ from those indicated in the Contract Documents.
2. Take photographs to show existing conditions adjacent to property before starting the Work.
3. Inspection shall include location and verification of all utility lines serving the Site.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 EXECUTION AND REMOVAL

- A. Furnish at the Site the required personnel, products, construction materials, equipment, tools, and supplies at scheduled time for installation or utilization.
- B. Perform a Post-Construction Survey and prepare a report for submittal with the request for Substantial Completion which compares the Pre-construction Survey with current conditions. Repair / replace damaged elements prior to requesting Substantial Completion or elements of existing work damaged during construction will be incorporated into Punch List I.
- C. If Contractor is notified by Engineer to perform an unscheduled demobilization, Contractor shall demobilize and have all equipment outside of the affected limits in accordance with the General Conditions.
- D. Upon completion of Punch List I work, Contractor shall remove construction tools, apparatus, equipment, unused materials and supplies, and personnel from the job site within seven calendar days.

PART 4 – MEASUREMENT AND PAYMENT

- A. When the Schedule of Bid Items includes a bid item for "*Mobilization*", the costs of work in advance of construction operations which are not directly attributable to any specific bid item will be paid for as a percentage of "*Mobilization*" and included in the progress estimate. When no such bid item is provided, payment for such costs will be considered to be included in the payment for the various items of work. Mobilization shall consist of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the Site and for all other work and operations which must be performed or costs incurred prior to beginning Work on the Site.

B. Payments for Mobilization will be made as follows:

1. When the monthly progress payment estimate of the amount earned, not including the amount earned for Mobilization, is five percent (5%) or more of the Contract Price, the total amount earned for Mobilization shall be forty percent (40%) of the Contract Unit Price bid for Mobilization or five percent (5%) of the Contract Price, whichever is less, and said amount will be included in said estimate for payment.
2. When the monthly progress payment estimate of the amount earned, not including the amount earned for Mobilization, is ten percent (10%) or more of the Contract Price, the total amount earned for Mobilization shall be sixty percent (60%) of the Contract Unit Price for Mobilization or seven percent (7%) of the Contract Price, whichever is less, and said amount will be included in said estimate for payment.
3. When the monthly progress payment estimate of the amount earned, not including the amount earned for Mobilization, is twenty percent (20%) or more of the Contract Price, the total amount earned for Mobilization shall be seventy percent (70%) of the Contract Unit Price for Mobilization or nine percent (9%) of the Contract Price, whichever is less, and said amount will be included in said estimate for payment.
4. When the monthly progress payment estimate of the amount earned, not including the amount earned for Mobilization, is fifty percent (50%) or more of the Contract Price, the total amount earned for Mobilization shall be eighty percent (80%) of the Contract Unit Price for Mobilization or ten percent (10%) of the Contract Price, whichever is less, and said amount will be included in said estimate for payment.
5. After completion of the Work, the remaining amount of the Contract Unit Price bid for Mobilization will be included in the final payment, subject to the requirements of General Conditions, GC-9.9.3.1. No separate payment shall be made for demobilization.

C. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation.
 - 2. Emergency manuals.
 - 3. Operation and maintenance manuals for systems, subsystems, and equipment.
 - 4. Maintenance manuals for the care and maintenance of products, materials, and finishes.

1.02 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.03 SUBMITTALS

- A. Submit operation and maintenance information required by each individual Technical Specification Section for review and approval a minimum of 90 days before requesting inspection for Substantial Completion. These components shall be submitted as individual submittals designated by each Technical Specification Section.
- B. After the component submittals noted above are complete, submit two (2) draft copies of all manuals 45 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Engineer will return one copy of the draft submittals and mark whether the general scope and content of manual are acceptable.
- C. After making all corrections to the manuals required by the Engineer, submit four (4) copies of all manuals in their final form to the Engineer.

1.04 COORDINATION

Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

1.05 COMMISSIONING AUTHORITY REVIEW

Prior to Substantial Completion, the Commissioning Authority (CxA) will review the operation and maintenance manuals for systems that were commissioned in accordance with Section 01 91 00, "COMMISSIONING". Materials may be added, or requested from the Contractor, to stress and enhance the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. This work does not supersede the Engineer's review of the operation and maintenance manuals.

PART 2 – PRODUCTS

2.01 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization: Include a section in the directory for each of the following:
 - 1. Table of contents.
 - 2. List of documents.
 - 3. List of systems.
 - 4. List of equipment.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.02 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Warranties
 - 4. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Specification Section, title and paragraph.
 - 2. Subject matter included in manual.
 - 3. Name and address of Project.
 - 4. Name and address of City.
 - 5. Date of submittal.
 - 6. Name, address, and telephone number of Contractor.
 - 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Include information, as necessary, for the City to be able to operate and maintain all systems as required by individual Technical Specification Sections. Organize into sets of manageable size, maximum 500 individual sheets of paper. Arrange contents according to Specification Section number in Project Manual for system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 1. Binders: Heavyweight, 3-ring, casebound, loose-leaf binders, with metal hinge construction in maximum 3 inch thickness, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Card-stock dividers with plastic-covered index tabs for each section and subsection. Mark each tab to indicate contents. Tab labels shall not be handwritten. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
 6. Warranties: As required by Section 01 70 00 "EXECUTION AND CLOSEOUT REQUIREMENTS."

2.03 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 1. Fire.

2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of City's operating personnel for notification of installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

2.04 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions.
 2. Performance and design criteria.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
1. Product name and model number.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.

8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.05 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in the manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds. Include procedures to follow and required notifications for warranty claims.

2.06 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in the manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard printed maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training videotape, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds. Include procedures to follow and required notifications for warranty claims.

PART 3 – EXECUTION

3.01 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by City's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by City's operating personnel.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 - 2. Comply with requirements of newly prepared Record Drawings in Section 01 70 00, "EXECUTION AND CLOSEOUT REQUIREMENTS."
- G. Comply with Section 01 70 00, "EXECUTION AND CLOSEOUT REQUIREMENTS," for schedule for submitting operation and maintenance documentation.

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.
- B. Final payment shall be withheld until required manuals and demonstration and training have been provided and accepted by the Engineer, per General Conditions GC-9.9.

END OF SECTION

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 SUMMARY

- A. Demonstration and training of products, equipment, and systems, to be commissioned and also those items indicated in specific Technical Specification Sections.
- B. Training of City, Tenant, and other operational personnel and users, as designated by Engineer, for operation and maintenance is required for each building and system for :
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.
 - 3. Plumbing equipment.
 - 4. Electrical systems and equipment.
 - 5. Items specified in individual product Sections.
- C. Training of City, Tenant, and other operational personnel and users, as designated by Engineer, in care, cleaning, maintenance, and repair is required for each building and system for :
 - 1. Roofing, waterproofing, and other weather-exposed, or moisture protection products.
 - 2. Fixtures and fittings.
 - 3. Items specified in individual product Sections.

1.02 SYSTEM DESCRIPTION

- A. The training of City, Tenant, and other operational personnel and users and shall encompass training in the management, operation, and maintenance of equipment and systems furnished under the Contract. Personnel to be trained include, but are not limited to, maintenance, engineering, and operations personnel.
- B. Demonstration and training shall enable City, Tenant, and other operational personnel and users to operate, service, enhance, maintain, and interact with, the hardware, software, and firmware, such that the equipment and systems will perform in accordance with Contract requirements.
- C. Management Responsibilities
 - 1. Engineer

- a. Reviews and coordinates demonstration and training provided by Contractor for City, Tenant, and other operational personnel and users.
 - b. Coordinates availability of and schedules City, Tenant, and other operational personnel and users for training sessions.
 - c. Verifies demonstration and training is complete.
- 2. Commissioning Agent (CxA)
 - a. Responsibilities for items to be commissioned as outlined in Section 01 91 00, "COMMISSIONING".
- 3. Contractor
 - a. Shall integrate demonstration and training activities into construction schedule. See Section 01 32 16, "NETWORK ANALYSIS AND PROJECT SCHEDULES".
 - b. Shall facilitate coordination of demonstration and training work by Engineer and CxA.
 - c. Shall provide and pay for qualified trainers and technicians to provide demonstration and training sessions
 - d. Shall provide and pay for all demonstration and training materials, equipment, and supplies in quantities to accommodate number of personnel in attendance.
- D. Training of City, Tenant, and other operational personnel and users, as designated by Engineer, for operation and maintenance including, but not limited to:
 - 1. All equipment and systems to be commissioned as listed in Section 01 91 00, "COMMISSIONING".
 - 2. All software-operated systems, software, and associated equipment.
 - 3. Items specified in individual Technical Sections.

1.03 SUBMITTALS

- A. See Section 01 33 00, "SUBMITTAL PROCEDURES".
- B. Submittals for demonstration and training on commissioned items:
 - 1. See Section 01 91 00, "COMMISSIONING" for additional requirements.
 - 2. Make all submittals specified in this Section, and elsewhere where indicated for commissioning purposes, to Engineer, for transmittal to the Commissioning Authority, unless directed otherwise by Engineer.
 - a. Submit an extra copy for the Commissioning Authority, not to be returned.
 - b. Make commissioning submittals on time schedule specified by Commissioning Authority through Engineer.
 - c. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of overall Training Plan; submit in editable electronic format.

- C. Demonstration and Training Plans: Engineer will designate personnel to be trained; Contractor shall tailor training to needs and skill-level of attendees.
 - 1. Submit Demonstration and Training Plans to Engineer.
 - 2. Submit not less than four weeks prior to start of training.
 - 3. Revise and resubmit until approved by Engineer.
 - 4. Submit resumes showing the qualifications of all instructors and lists of subcontractors or equipment manufacturers who will participate in training.
- D. Demonstration and Training Schedule
 - 1. Provide a schedule showing all demonstration and training sessions.
 - 2. Include the following milestones and coordinate with Section 01 78 23, "OPERATION AND MAINTENANCE DATA" and Section 01 91 00, "COMMISSIONING".
 - a. Operation and Maintenance Manuals (Draft)
 - b. Training Plans
 - c. Operation and Maintenance Manuals (Complete Draft)
 - d. Instructor Guides and Attachments
 - e. Training Demonstrations
 - f. Training Reports
 - 3. Coordinate training schedule with Section 01 32 16, "NETWORK ANALYSIS AND PROJECT SCHEDULES". Show training schedule milestones in calendar relation to project milestones indicated in the Construction Schedule.
- E. Training Manuals: Provide training manual for each attendee; allow for minimum of two, and a maximum of ten, attendees per training session.
 - 1. Include applicable portion of Operation and Maintenance manuals.
 - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in Operation and Maintenance manuals.
 - 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- F. Training Reports
 - 1. Identification of each training session, date, time, and duration.
 - 2. Sign-in sheet showing names and job titles of attendees.

3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
 4. Include Commissioning Authority's formal acceptance of training session.
- G. Video Recordings: Submit digital video recording of each demonstration and training session for City's subsequent use.
1. Format: DVD Disc or Flash Drive, as requested by the Engineer.
 2. Label each recording and container with session identification and date.

1.04 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this Section, unless approved in advance by Engineer.
- B. Demonstrations conducted during Functional Testing need not be repeated unless City, Tenant, and other operational personnel and user training is specified or is required by Engineer.
- C. Demonstration may be combined with City, Tenant, and other operational personnel and user training if applicable and approved by Engineer.
- D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
1. Perform demonstrations not less than two (2) weeks prior to Substantial Completion.
 2. For equipment or systems requiring seasonal operation, perform demonstration within six (6) months of season.
- E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
1. Perform demonstrations not less than two (2) weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Contractor shall prepare a Training Plan for each item requiring training and shall include the following elements:
 - 1. A flow diagram, indicating the logical progression of sessions in relation to the Training Schedule to illustrate maximum effectiveness where needed.
 - 2. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm(s) and person(s) conducting or participating in training to match resumes and lists submitted as indicated in Part 1, Article - Submittals.
 - d. Intended audience, such as job description.
 - e. Prerequisite knowledge of attendees, when needed.
 - f. Objectives of training and suggested methods of ensuring adequate training.
 - g. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - h. Media to be used, such as slides, hand-outs, etc.
 - i. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- B. Conduct training on-site unless otherwise approved by Engineer.
- C. Contractor shall provide classroom and seating at no cost to City.
- D. Do not start training until Functional Testing is complete, but not less than two (2) weeks prior to Substantial Completion, unless otherwise approved by the Engineer or the Commissioning Authority, through the Engineer.
- E. Provide training in minimum two (2) hour segments.
- F. The Commissioning Authority, through the Engineer, is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- G. Training schedule will be subject to availability of City, Tenant, and other operational personnel and users to be trained. Contractor shall re-schedule training sessions as required by Engineer. Once schedule has been approved by Engineer, failure to conduct sessions according to schedule will be cause for City to charge Contractor for personnel "show-up" time.
- H. Review of Facility Policy on Operation and Maintenance Data, during training discuss:
 - 1. The location of the Operation and Maintenance manuals and procedures for use and preservation, and backup copies.

2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
3. Typical uses of the Operation and Maintenance manuals.

I. Product- and System-Specific Training:

1. Review the applicable Operation and Maintenance manuals.
2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
4. Provide hands-on training on all operational modes possible and preventive maintenance.
5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
6. Discuss common troubleshooting problems and solutions.
7. Discuss any peculiarities of equipment installation or operation.
8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
9. Review recommended tools and spare parts inventory suggestions of manufacturers.
10. Review spare parts and tools required to be furnished by Contractor.
11. Review spare parts suppliers and sources and procurement procedures.

- J. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three (3) days.

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 01 91 00

COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

- A. The work specified in this Section consists of performing commissioning per City requirements.

1.02 DEFINITIONS

- A. Commissioning – Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the City's requirements. Commissioning during the construction, acceptance, and warranty phases is intended to achieve the following specific objectives:
 - 1. Verify and document that equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards and the Contract Documents.
 - 2. Verify and document that equipment and systems receive complete operational checkout by installing Contractors.
 - 3. Verify and document equipment and system performance.
 - 4. Verify the completeness of operations and maintenance materials.
 - 5. Ensure that the operating personnel are adequately trained on the operation and maintenance of building equipment.
 - 6. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
- B. Commissioning Plan – The Commissioning Plan will be prepared by the Commissioning Authority. The Plan requirements will be consistent with LEED requirements in terms of responsibilities for each member of the Commissioning Team. The overall plan provides the structure, schedule and coordination planning for the commissioning process for each building under consideration. Commissioning requirements of the Contractor are described within these Specifications and in other Sections as listed in Article 1.02, Related Sections. Following award of the Contract, the City's Commissioning Authority will develop the Commissioning Plan with the Commissioning Team describing responsibilities of the commissioning team members and timing of the commissioning activities.
- C. Deficiency - A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract Documents, and does not perform properly.
- D. Functional Performance Test - Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional Performance testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chillers/ cooling towers/ pumps are all tested interactively with the chiller's different functions to see if the pumps and cooling towers ramps up and down to maintain the differential pressure and temperature setpoints). Systems are tested under various modes, such as during low

cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing. In the commissioning sense of the word, TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The Commissioning Authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is performed by the installing Contractor or vendor. Functional Performance Tests are performed after prefunctional checklists and startup are complete (there are LEED sample forms that may be helpful in understanding tests that may be required).

- E. Manual Test - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- F. Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.
- G. Non-Compliance - see Deficiency.
- H. Non-Conformance - see Deficiency.
- I. Prefunctional Checklist - a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Commissioning Authority to the Contractor. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, correct oil levels, labels affixed, gages in place, sensors calibrated, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word "prefunctional" refers to activities prior to functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist (there are LEED sample forms that may be helpful in understanding tests that may be required).
- J. Seasonal Performance Tests - Functional Performance Test that are deferred until the system(s) will experience conditions closer to their design conditions.
- K. Warranty Period – Refer to General Conditions GC-3.5, "Warranty and Correction".

1.03 COORDINATION

A. Commissioning Team

- 1. Commissioning Authority (CxA), hired by the City
- 2. Contractor
- 3. Engineer
- 4. Additional representatives determined by Contractor or Engineer.

B. Management

- 1. Commissioning Authority (CxA)
 - a. Under contract with the City.

- b. Manages commissioning process with assistance of Commissioning Team.

C. Scheduling

1. CxA to work with TTS (Tenant's Technical Staff), Engineer, and Contractor to schedule commissioning activities.
2. Contractor to integrate commissioning activities into master construction Schedule.
3. Involved parties to address scheduling issues in timely manner to expedite commissioning process.

1.04 COMMISSIONING PROCESS

The following activities describe the commissioning tasks coordinated by CxA and Contractor during construction in order of occurrence.

1. City-prepared Commissioning Plan: Will provide guidance in execution of commissioning process. Note: Specifications take precedence over Commissioning Plan.
2. Coordination Meeting: Members of design and construction team involved in the commissioning process shall meet and agree on implementation of work, tasks, Schedules, deliverables, and responsibilities for implementation of Commissioning Plan.
3. Submittals: Equipment documentation submitted to CxA during normal submittals, including detailed start-up procedures.
4. Start-Up/Pre-Functional Checklists: CxA works with Contractor and Engineer to develop startup plans and documentation formats, including providing Contractor with pre-functional checklists to be completed during startup process.
5. Functional Performance Testing: CxA develops specific equipment and system functional performance test procedures.
 - a. Contractor reviews the test procedures.
 - b. Procedures to be executed by Contractor under direction of, and documented by CxA.
6. Deficiencies and Resolution: CxA documents items of non-compliance in materials, installation or operation. Items are corrected at Contractor expense and equipment or systems are retested.
7. Operations and Maintenance Documentation: CxA reviews Operation and Maintenance documentation for completeness.
8. Training: CxA reviews and coordinates training provided by Contractor and verifies it is completed.
9. Seasonal Testing: Deferred or seasonal testing is conducted, as required.

1.05 COMMISSIONING RESPONSIBILITIES

- A. Services for Tenant's Technical Staff (TTS) are not a part of this Contract and Contractor is not responsible for providing their services.

1. TTS' responsibilities are listed herein to clarify commissioning process.

B. Commissioning Authority (CxA)

1. Primary Role: Develop and coordinate the execution of testing plan to verify and document systems are functioning in accordance with design intent and Construction Documents.
2. May assist with problem-solving deficiencies, but ultimately that responsibility resides with the Contractor and Engineer.
3. Not responsible for design concept, design criteria, code compliance, general construction Scheduling, cost estimating, or construction management.
4. Construction and Acceptance Phase
 - a. Coordinates and directs commissioning activities.
 - b. Work with Contractor to ensure commissioning activities are scheduled.
 - c. Maintain up-to-date Commissioning Plan.
 - d. Help plan and conduct commissioning scoping meeting and controls integration meetings.
 - e. Request and review additional information required to perform commissioning tasks, including Operating and Maintenance materials, contractor start-up and checkout procedures, and sequences of operation.
 - f. Review Contractor submittals applicable to commissioned systems, concurrent with Engineer reviews.
 - g. Develop start-up and checkout plans with Contractor.
 - h. Write and distribute pre-functional checklists, tests and start-up forms.
 - i. Perform site visits to observe component and system installations.
 - j. Attend construction job-site meetings to monitor construction and commissioning progress.
 - k. Review completed pre-functional checklist and start-up reports from contractor.
 - l. Assist with coordination of start-up requirements with TAB requirements.
 - m. Write functional performance test procedures for equipment and systems.
 - n. Coordinate, witness, and document functional performance tests completed by Contractor.
 - o. Coordinate retesting as necessary until satisfactory performance is verified.
 - p. Maintain master deficiency and resolution record and provide Engineer with written progress reports and test results with recommended actions.

- q. Review training proposed by Contractor for City, Tenant, and other operational personnel and users.
- r. Review Operating and Maintenance manuals.
- s. Prepare Final Commissioning Report.

C. Engineer

1. Construction and Acceptance Phase

- a. Attend commissioning scoping meeting, controls integration meeting and additional meetings, as necessary.
- b. Provide design intent and sequence of operation documentation as required by CxA.
- c. Assist in resolution of system deficiencies identified during commissioning.
- d. Review and approve Operations and Maintenance manuals.
- e. Optional: Witness equipment start-up and performance testing.

2. Warranty Period

- a. Assist in resolution of system deficiencies identified during warranty period commissioning.

D. Tenant's Technical Staff (TTS) and Engineer

1. Construction and Acceptance Phase

- a. Plan and Attend commissioning scoping meeting, controls integration meeting and additional meetings, as necessary.
- b. Arrange for City, Tenant, and other operational personnel and users to participate in commissioning activities and training sessions.
- c. Provide final acceptance for commissioning work.

2. Warranty Period

- a. Ensure seasonal or deferred testing and deficiency issues are addressed.

E. Contractor

1. Construction and Acceptance Phase

- a. Facilitate coordination of commissioning work by CxA.
- b. Attend commissioning scoping meeting, controls integration meeting and additional meetings, as necessary.
- c. Furnish copies of construction documents, addenda, change orders and approved submittals and design drawings related to commissioned equipment to CxA.

- d. Execute commissioning responsibilities according to Specifications and Commissioning Plan.
- e. Coordinate training of City, Tenant, and other operational personnel and users.
- f. Prepare O&M manuals, according to Specifications, including updating original sequences of operation to Record (as-built) conditions.
- g. Develop start-up and checkout plan for commissioned equipment based on manufacturer's recommendations and pre-functional checklists from CxA.
 - 1) Submit to CxA for review and approval prior to start-up.
- h. Provide additional requested documentation, prior to normal O&M manual submittals, to CxA for development of start-up and functional testing procedures.
- i. Assist in clarification of operation and control of commissioned equipment where Specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- j. Help develop start-up and checkout plan for commissioned equipment based on manufacturer's recommendations and pre-functional checklists from CxA.
- k. During startup and checkout process, execute pre-functional checklists for commissioned equipment.
 - 1) Perform and document completed startup and system operational checkout procedures.
- l. Resolve punch list items before functional testing.
 - 1) Air and water TAB to be completed with discrepancies and problems resolved before functional testing.
- m. Perform functional performance testing, under direction of CxA, for commissioned equipment.
- n. Resolve equipment or system deficiencies and retest as required to verify modified performance.
- o. Prepare Operation and Maintenance manuals according to Specifications, including updating original sequences of operation to record conditions.
- p. Provide training of City, Tenant, and other operational personnel and users.
- q. Coordinate with equipment manufacturers to determine requirements to maintain validity of warranties.

2. Warranty Period

- a. Execute required seasonal or deferred functional performance testing.
- b. Correct deficiencies and make necessary adjustments to Operation and Maintenance manuals and Record Drawings for issues identified during warranty period.

- c. Contractor (for System Controls): Commissioning responsibilities of Contractor (for System Controls), during construction and acceptance phases in addition to those listed in Section 15995, "Mechanical Systems Commissioning" are:
- 3. Sequences of Operation Submittals. Temperature controls submittals to include complete and detailed sequences of operation for each piece of equipment, regardless of completeness and clarity of sequences in Specifications and include:
 - a. Narrative description of system, describing its purpose, components and function.
 - b. Interactions and interlocks with other systems.
 - c. Delineation of control interactions between packaged controls and building automation system, including listing of monitored points, controlled points, and adjustable points.
 - d. Written sequences of control for packaged controlled equipment.
 - e. Sequences of control for modes of operation (Start-up, Warm-up, Cool-down, Normal occupied, Unoccupied, Emergency Shutdown, etc.).
 - f. Capacity control sequences and equipment staging.
 - g. Temperature and pressure control sequences (setbacks, resets, etc.).
 - h. Sequences for control strategies (economizer control, optimum start/stop, optimization, demand limiting, etc.).
 - i. Effects of power or equipment failure with standby component functions.
 - j. Sequences for alarms and emergency shutdowns.
 - k. Seasonal operational requirements.
- l. Control Drawings Submittal
 - 1) Control drawings to have key to abbreviations.
 - 2) Control Drawings: Provide graphic schematic depictions of systems and each component.
 - 3) Schematics to include system and component layout of equipment that control system monitors, enables or controls, even if equipment is primarily controlled by packaged or integral controls.
 - 4) Provide full points list with following included for each point:
 - a) Controlled system
 - b) Point abbreviation
 - c) Point description
 - d) Point type (digital/analog, input/output)

- e) Display unit
 - f) Control point or setpoint (Yes / No)
 - g) Monitoring point (Yes / No)
 - h) Intermediate point (Yes / No)
 - i) Calculated point (Yes / No)
4. Record Drawing version of control drawings and sequences of operation to be included in final controls Operation and Maintenance manual submittal.
 5. Prepare written plan indicating step-by-step manner, and procedures that will be followed to test, checkout and adjust control system prior to functional performance testing.
 6. Signed and dated certification to CxA and Engineer upon completion of control system checkout.
 7. Equipment Suppliers
 - a. Provide requested submittal data, including detailed start-up procedures and specific responsibilities of Tenant to keep warranties in effect.
 - b. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
 - c. Assist in equipment testing as required.

Commissioning Scope: Equipment to be commissioned in this project checked.

System	Equipment	Check
HVAC System		
	Pumps	X
	Variable frequency drives	X
	Roof Top Units	X
	Terminal units	X
	Split System Fan Coils	X
	Exhaust fans	X
Plumbing Systems		
	Service water heaters	X
	Pumps	X

System	Equipment	Check
Electrical System		
	Overhead Crane	X
	Main Electrical Services with Metering	X
	Emergency Generator	X
	Lighting Control Panel	X
	Emergency power system & ATS	X
	UPS Systems	X

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

- A. Standard testing equipment required to perform startup and initial checkout and required functional performance testing to be provided by Contractor for equipment being tested.
- B. Testing equipment to be of sufficient quality and accuracy to test or measure system performance as required by Specifications.
 - 1. Data logging equipment or software required to test equipment to be provided by Contractor (for System Controls) but shall not become property of City or Tenant.

PART 3 - EXECUTION

3.01 MEETINGS

- A. Scoping Meeting:
 - 1. CxA will Schedule, plan and conduct Commissioning Scoping Meeting and Controls Integration Meetings with entire commissioning team in attendance.
 - 2. Engineer to distribute meeting minutes to those in attendance.
- B. Miscellaneous Meetings: Other meetings to be planned and conducted by CxA as construction progresses.
 - 1. Meetings to cover coordination, deficiency resolution and planning issues.

3.02 REPORTING

- A. Regular Reports: CxA to provide regular reports to Engineer with increasing frequency as construction and commissioning progresses.
- B. Progress Reports: CxA to regularly communicate with commissioning team, apprising them of commissioning progress and Scheduling changes through memos, progress reports, etc.

- C. Commissioning Report: CxA compiles final Report which summarizes tasks, findings, and documentation of commissioning process.
 - 1. Report addresses actual performance of building systems in reference to design intent and contract documents.
 - 2. Report includes:
 - a. Completed pre-functional inspection checklists
 - b. Functional performance testing records
 - c. Diagnostic monitoring results
 - d. Identified deficiencies
 - e. Recommendations
 - f. Summary of commissioning activities
 - g. Basis of Design
 - h. Single line drawings
 - i. Sequence of control
 - j. Operation and Maintenance instruction
- D. Commissioning Schedule: Develop Schedule in accordance with Section 01 32 16, "NETWORK ANALYSIS AND PROJECT SCHEDULES".

3.03 SUBMITTALS

- A. CxA reviews submittals related to commissioned equipment for conformance to Construction Contract Documents as it relates to commissioning process.
 - 1. Reviews intended primarily to aid in development of functional performance test procedures.
- B. CxA may submit written requests for additional information from Contractors to facilitate the commissioning process.
- C. CxA may request additional design and operations narrative from Contractor (System Controls) and Engineer.

3.04 START-UP, PREFUNCTIONAL INSPECTION CHECKLISTS

Following procedures apply to equipment commissioned, according to Commissioning Scope outlined herein.

- A. General: Pre-functional Inspection Checklists are developed and completed for major equipment and systems being commissioned.
 - 1. Checklist documents equipment nameplate and characteristics data and confirms as-built status of equipment or system.

2. Checklists ensure systems are complete and operational, so functional performance testing can be scheduled.
- B. Start-up Plan. CxA assists responsible contractors in developing detailed start-up plans for equipment.
1. Primary role of CxA in this process is to ensure there is written documentation and that each manufacturer-recommended procedures is completed.
 2. CxA creates pre-functional checklists, based primarily on manufacturer's startup and checkout procedures. Each start-up item will have date and initial line for completion by contractor during start-up.
 3. Start-up plans and documentation to be provided to Engineer for review.
- C. Completion of Pre-functional Inspection Checklists and Startup:
1. Contractor and equipment suppliers schedule startup and checkout with Engineer and CxA.
 2. CxA to observe start-up procedures for each piece of primary equipment.
 - a. Multiple Units: Sampling strategy may be used according to commissioning plan.
 3. Lower-level equipment components (e.g., VAV boxes, reheat coils) CxA to observe sampling of start-up procedures.
 - a. Sampling procedures are identified in commissioning plan.
 4. Contractor and vendors execute startup and provide CxA with signed and dated copy of completed start-up and pre-functional inspection checklists.
 5. Only individuals who have completed or witnessed line item task to make initials or checks on forms.
- D. Deficiencies, Non-Conformance and Approval in Checklists and Startup.
1. Clearly list any items of start-up and pre-functional procedures not successfully completed at bottom of form or on an attached sheet.
 - a. Procedures form and any outstanding deficiencies are provided to CxA within two days of test completion.
 2. CxA reviews and verifies pre-functional inspection checklists and start-up reports and recommends approval to Engineer.
 3. CxA assists Contractor and vendors to correct and retest deficiencies or uncompleted items, involving other members of Commissioning Team as necessary.

3.05 FUNCTIONAL PERFORMANCE TESTING

Following procedures apply to all equipment commissioned, according to Commissioning Scope described herein and to all commissioning functional performance testing.

A. Objectives and Scope

1. Demonstrate each system is operating according to the design and Construction Documents.
2. Functional performance testing comprises tests to verify components, equipment, systems, and interfaces between systems operate correctly and includes operating modes, interlocks, control sequences, and responses to emergency conditions.
3. Verification procedures are directed, witnessed, and documented by CxA.

B. Development of Test Procedures

1. CxA develops specific test procedures and forms to verify and document proper operation of each piece of equipment and system.
2. CxA provides test procedures to Contractor to review the tests for feasibility, safety, equipment and warranty protection prior to execution.
3. CxA may submit tests to Engineer for review.
4. Test procedure forms, developed by CxA, to include the following information
 - a. System, equipment, and component names.
 - b. Equipment location and ID number.
 - c. Date.
 - d. Project name.
 - e. Participating parties.
 - f. Instructions for setting up test, including special cautions, and alarm limits.
 - g. Specific step-by-step procedures to execute test.
 - h. Acceptance criteria of proper performance with date passed and initials boxes.
 - i. Section for comments or notes.

C. Execution of Functional Performance Tests

1. Test Methods: Functional performance testing and verification may be achieved by direct manipulation of system inputs (i.e. heating and cooling sensors), manipulation of system inputs with building automation system (i.e. software override of sensor inputs), trend logs of system inputs and outputs using building automation system, or short-term monitoring of system inputs and outputs using stand alone data loggers.
 - a. Combination of methods may be required to test complete sequence of operations.
 - b. CxA determines which method, or combination, is most appropriate.
2. Setup: Each test procedure is performed under conditions that simulate normal operating conditions as closely as possible.

3. Provide necessary system modifications to produce specified conditions (flows, pressures, and temperatures) necessary to execute test and, at completion of test, returns affected building equipment and systems to their pre-test conditions.
 4. Sampling: Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using sampling strategy developed by CxA and approved by Engineer
 - a. Test values: After three attempts at testing, if specified sample percentage, failures are still present, remaining units are tested at Contractor's expense.
- D. Coordination and Scheduling: Provide sufficient notice to CxA regarding completion Schedule for pre-functional checklists and startup of equipment and systems.
1. CxA schedules functional tests through Engineer and Contractor and following sequential priorities followed:
 - a. Equipment is not "temporarily" started (for heating or cooling), until pre-start checklist items and manufacturer's pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
 - b. Functional performance testing does not begin until pre-functional, start-up and TAB is completed for given system.
 - c. Controls system and equipment it controls are not functionally tested until points have been calibrated and pre-functional checklists are completed.
- E. Problem Solving
1. CxA may recommend solutions to deficiencies identified during functional testing. Contractor to resolve, correct and retest deficiencies.

3.06 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation

1. CxA witnesses and documents results of functional performance tests using forms developed for that purpose.
 - a. Prior to testing, forms are provided to Contractor and Engineer for review.

B. Non-Conformance

1. CxA records results of functional test on procedure or test form.
 - a. Deficiencies identified during verification testing are documented on standard form and reported to Engineer and Contractor.
 - b. Deficiency Report: Includes details of components or systems found to be non-compliant with parameters of test plans.
 - c. Report detail adjustments or alterations required to correct system operation, and identifies responsible party.
2. Corrections of minor deficiencies identified may be made during tests at discretion of CxA and deficiency and resolution documented on procedure form.

3. Make every effort to expedite testing process and minimize unnecessary delays, while not compromising integrity of procedures.
4. Identified deficiency resolution
 - a. No dispute on deficiency and responsibility to correct it:
 - 1) CxA documents deficiency and adjustments or alterations required to correct it.
 - 2) Contractor corrects deficiency and notifies CxA that equipment is ready to be retested.
 - 3) CxA reschedules test and test is repeated.
 - b. Dispute about deficiency or who is responsible:
 - 1) Deficiency is documented on non-compliance form and copy given to Engineer and Contractor.
 - 2) Resolutions are made at lowest management level possible and additional parties are brought into discussions as needed.
 - a) Final interpretive authority is with Engineer.
 - b) Final acceptance authority is with City.
 - 3) CxA documents resolution process.
 - 4) Once interpretation and resolution have been decided, appropriate party corrects deficiency and notifies CxA that equipment is ready to be retested.
 - a) CxA reschedules test and test is repeated until satisfactory performance is achieved.

C. Cost of Retesting

1. Contractor is
 - a. Responsible for costs to retest pre-functional or functional test, if they are responsible for deficiency.
 - b. If not responsible for deficiency, cost recovery for retesting costs to be negotiated with Contractor.
2. Time for CxA and Engineer to direct any retesting because pre-functional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to Contractor.

D. Approval

1. CxA makes formal approval of functional performance test after review.
2. CxA recommends acceptance of each test to Engineer.
3. Engineer gives final approval on each test.

3.07 DEFERRED TESTING

- A. Unforeseen Deferred Tests: Functional testing that cannot be completed due to building structure, required occupancy condition, or other deficiency may be delayed upon approval of Engineer.
 - 1. Tests are conducted in same manner as seasonal tests as soon as possible.
- B. Seasonal Testing: Seasonal variation in operations or control strategies may require additional testing during opposite season to verify performance of HVAC system and controls.
 - 1. During warranty period: Seasonal testing and other deferred testing is completed as required to fully test sequences of operation.
 - 2. Engineer and Contractor coordinate these activities.
 - 3. Tests are executed and documented, with deficiencies corrected by Contractor.
 - 4. Final adjustments to operation and maintenance manuals and Record Drawings due to testing are also completed.

PART 4 – MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for any Work covered by this Section. The cost of this Work shall be considered incidental to and included in the prices of other related work provided in the Schedule of Bid Items.

END OF SECTION

SECTION 02 41 00
DEMOLITION AND REMOVALS

PART 1 – GENERAL

1.01 SUMMARY

- A. The work of this Section consists of performing demolition, disposal, and removal of the related Work complete, and as indicated on the Drawings and as specified, including but not limited to removal and disposal of existing pavement and base materials, asphalt concrete paving, PCC paving, concrete curb and gutters, cross gutters, sidewalk, foundations, and underground footings. All existing items that need to be removed and disposed of to complete the work as described in the Contract Documents.
- B. Contractors shall familiarize themselves with the Supplemental Drawings, Reference Drawings, and the project specific Soil Environmental Characterization Data Reports included in Appendix CC, prior to performing any demolition and removal activities.
- C. Contractor should also review and be familiar with the requirements of Earthwork Section 31 00 00 for requirements of testing and providing required information during the process of removals.

1.02 SUBMITTALS

- A. In accordance with Section 01 33 00, "SUBMITTAL PROCEDURES," the Contractor shall submit to the Engineer a demolition plan, which addresses the following:
 - 1. Scope of items to be removed and disposed of.
 - 2. Measures taken to protect the public.
 - 3. Air quality control plan (dust control).
 - 4. Material Testing Protocol.
 - 5. Protection of the environment.
 - 6. Haul routes (On-Site and Off-Site routes).
 - 7. Means and methods to maximize the recovery for recycling of demolished materials.
 - 8. Certification of proposed weigh scales and weighmaster's license.
 - 9. Permits and approval from the appropriate regulatory agencies.
 - 10. Storm water drainage and erosion control plan.
 - 11. Off-site disposal sites.
 - 12. Proof of material disposal.
 - 13. Product information.

14. Removal, storage, transportation, and disposal work plan.
15. Sequencing plan.
16. Pothole information.
17. Work plan for each utility to be interrupted, capped, abandoned, or cut off with minimum information:
 - a. Date/time of work.
 - b. Duration of work.
 - c. Limits of work.
 - d. Description of activity.

1.03 QUALITY ASSURANCE

- A. The extent and location of Work is indicated on the Drawings.
- B. Underground structures and utilities may not be in the exact location shown.
- C. Demolition work indicated on the Drawings and described herein indicates typical features and types of structures to be demolished. It is not to be construed as definitive or adequate to supplant the actual on-site inspection by the Contractor.
 1. Contractor has obligation to be familiar with Supplemental Drawings, Appendices, and existing conditions.

1.04 REGULATORY REQUIREMENTS

- A. Contractor shall use any means at his disposal for the demolition, providing means that conform to all applicable federal, state and local codes and regulations, and these Specifications, including the City of Los Angeles Construction Waste Recycling Ordinance. Contractor shall obtain all necessary permits for his selected means of demolition.
- B. Obtain required permits from the appropriate regulatory agencies for the demolition, transportation and disposal of materials not specified to be recycled on the Site.
- C. Notify affected utility companies before starting Work and comply with their requirements.
- D. Do not close or obstruct public roadways, sidewalks or hydrants without obtaining the appropriate permits or approvals.
- E. Potentially contaminated soils will be encountered as a part of this work. Refer to Section 31 00 00, "Earthwork" and referenced documents in the appendices regarding the potential presence of, handling and disposal of soil materials that may be encountered as a part of the work.
- F. Do not use explosives on this project.

1.05 SITE CONDITIONS

- A. Contractor shall review the Reference Documents, Appendices and Supplemental Drawings, and inspect the Site for existing conditions and items that will need to be demolished.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Products required to accomplish the Work of this Section shall be selected by the Contractor, subject to the approval of the Engineer in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES," unless otherwise noted.

2.02 EQUIPMENT

- A. Appendix Q Construction and Demolition Waste Recycling Program: The Contractor shall provide all equipment necessary to comply with this Ordinance.

PART 3 – EXECUTION

3.01 SCOPE

- A. Removals shall in performed in accordance with the SSPWC 'Greenbook' Section 401.
- B. Demolish and remove any above and below grade structures and facilities, identified on the Drawings for demolition.
- C. Remove, wholly or in part, and legally dispose off-site all utilities, drainage systems, site improvements, foundations, and amenities, above and below ground, as indicated and specified in the Contract Documents or as required to complete the Work.
- D. Existing roadway base materials are to be excavated, stockpiled on site, tested and removed from the project site. The Port of Long Beach will not accept existing base materials for recycling.
- E. Cut and cap existing utilities in accordance with SSPWC 'Greenbook' Section 306-5, where indicated on the Drawings.
- F. Existing AC paving and concrete is to be sawcut, broken up, loaded, hauled, and off loaded at the POLB Rubble Site as outlined in the permit requirements identified in Appendix P.
- G. Utilities to be terminated:
 - 1. Remaining portions of some existing utility services will be required to be protected in place, as indicated on the Drawings. Any damage by Contractor to these existing facilities shall be repaired by Contractor at no additional cost to City. Coordinate Work with the separate contractors on the terminal.
- H. All oil lines are active unless noted otherwise.
- I. Provide protection around excavations or backfill and compact with approved fill material.

3.02 PREPARATION

- A. Review Supplemental and Reference Drawings to identify utilities and obstructions that are not shown or are unclear. Contact and/or coordinate with Los Angeles Department of Water and Power and/or Southern California Edison and California Resources Corporation (Thums/Tidelands).
- B. Prior to beginning removal of AC paving materials the Contractor is to coordinate with the Port of Long Beach and obtain a permit to haul materials to the POLB Rubble Site as outlined in Appendix P.
- C. Provide, erect and maintain temporary barriers, security and other such precautions as are required.
- D. Employ measures required to adequately protect existing structures, pavements, utilities and other features designated to remain.
- E. Mark locations of utilities and structures, which are to be protected in place. Provide high visibility yellow plastic tape around perimeters of all items to be protected in place. Place signs indicating that structures and utilities are to be protected in place.
- F. Prevent movement or settlement of adjacent structures and/or utilities that are to remain in use. Provide the necessary shoring to ensure the protection of such adjoining structures.

3.03 GENERAL PROCEDURES

- A. The demolition Work shall be sequenced. Do not perform demolition of any structure or facility prior to removal of any found hazardous or contaminated materials and acceptance of same by the Engineer. Pick-up all the trash left by the tenant after vacating the site. If the trash requires more than a 20 cubic yard container, then it will be treated as changed conditions.
- B. Contractor shall cease operations if public safety is compromised or suspected of being compromised. Operations shall not resume until public safety has been secured.
- C. Contractor shall conduct operations to minimize inconvenience or interference with streets and roads that are to remain in use. Contractor shall provide and maintain the necessary traffic control to ensure public safety.
- D. Contractor shall employ necessary controls to prevent the tracking of materials from the Site onto terminal pavement, public streets and roads. Street sweepers and other cleaning methods shall be employed to affect the cleanup, if tracking occurs.
- E. Burning of debris at the Site is not permitted.
- F. Fill all holes and other excavations resulting from demolition operations in accordance with other Sections of this Specification in order to maintain a usable surface.
- G. Dust shall be controlled in accordance with Appendix R and specified Temporary Environmental Controls and mitigation measures.

3.04 DEMOLITION OF STRUCTURES

- A. Completely remove and dispose materials for structures, fences, and other obstructions

as indicated on the Drawings or as necessary to complete the Work.

- B. Cut exposed reinforcement flush against limits of demolition.
- C. The Contractor shall saw cut existing structures to their full depth to provide a clean, smooth edge at limits of demolition and at locations of existing facilities to remain.
- D. Concrete and other preapproved materials may be delivered to the POLB Rubble Site location within the Harbor District off Pier S Avenue as indicated on the Drawings. Refer to Appendix P for pre-approval requirements.

3.05 DEMOLITION OF UTILITIES AND SUBSURFACE STRUCTURES

- A. Contractor shall protect existing structures and utilities indicated on the Drawings to remain and will be held responsible for any damage including incidentals resulting from his failure to protect these facilities adequately.
- B. All utilities and their appurtenances, manholes, vaults, foundations or other subsurface structures that are identified on the Drawings for demolition/removal shall be demolished and removed.
- C. Cap utilities at construction limit in accordance with SSPWC Section 306-5, as indicated on the Drawings.
- D. Storm drains that are to remain functional shall be protected from the infiltration of debris and silts.

3.06 DEMOLITION OF PAVEMENT AND SIMILAR STRUCTURES

- A. Demolish and remove all pavements and other miscellaneous items, except those indicated as "protect-in-place". Removals shall conform to SSPWC Section 401 or the Brown Book alterations as applicable.
- B. Broken Asphalt Concrete Pavement and Portland Cement Concrete Pavement shall be broken up to specified maximum size "processed" and delivered to the POLB Rubble Site location per requirements outlined in Appendix P.
- C. Remove surplus soil in accordance with Section 31 00 00, "EARTHWORK" and referenced appendices.
- D. Concrete previously exposed to the marine environment shall be cleaned of any debris and growth prior to break up and delivery.
- E. The POLB Rubble Site will not accept soil, CMB, crushed rock base, CTB, asphalt concrete from grinding, or concrete rubble from wheel stops.

3.07 REMOVAL OF UTILITIES

- A. All utilities and their structures indicated on the Drawings to be removed shall conform to SSPWC Section 306-3.3, unless noted otherwise.

3.08 DISPOSAL

- A. Contractor shall be responsible for paying all required transportation costs and disposal and tipping fees.

3.10 CLEANING

- A. After removal of structures, foundations, utilities, pavements, other reinforced concrete, and any other features, the area(s) shall be cleaned and graded to prevent ponding or conditions that impede subsequent Work at the Site. There shall be no debris, rubble or litter left at the Site from the demolition activities.

PART 4 – MEASUREMENT AND PAYMENT

- A. Demolition and Removals as specified herein shall be included in the measurement and payment for "Demolition".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other Work shall be considered incidental.

END OF SECTION

SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure as indicated on Drawings.
 - 2. Demolition and removal of selected utilities and site elements as indicated on Drawings.
 - 3. Salvage of existing metal and plastic items to be reused or recycled.

1.02 DEFINITIONS

- A. Demolition: Demolition is the process of tearing apart and removing any feature of a facility together with any related handling and disposal operations.
- B. Deconstruction: Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful building materials.

1.03 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to the City that may be uncovered during demolition remain the property of the City.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to the City.

1.04 PREINSTALLATION MEETINGS

- A. Pre-Demolition Meeting: Conduct meeting at Project Site.

1.05 INFORMATIONAL SUBMITTALS

- A. Engineering Survey: Submit engineering survey of condition of building.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of selective demolition activities with starting and ending dates for each activity.
- D. Predemolition photographs or video.

- E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.06 CLOSEOUT SUBMITTALS

- A. Inventory of items that have been removed and salvaged.

1.07 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.08 FIELD CONDITIONS

- A. City will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so City's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by the City as far as practical.
- C. Notify the Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by the City before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify the Engineer. Hazardous materials will be removed by the City under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.
- G. Arrange selective demolition schedule so as not to interfere with the City's operations.

1.09 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.
 - 1. Maintain the existing building facade where indicated to remain. Do not demolish such existing construction beyond indicated limits.
 - 2. Maintain the existing building structural systems where indicated to remain. Do not demolish such existing construction beyond indicated limits.
 - 3. Maintain the existing interior ceilings, interior partitions, and/or demountable walls where indicated to remain. Do not demolish such existing construction beyond indicated limits.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
- C. Identify with the City all equipment and construction to remain in-place during selective demolition and construction, flag it with warning tape and protective barriers.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. City will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.

- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to City.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.03 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- B. Remove temporary barricades and protections where hazards no longer exist.

3.04 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 4. Maintain fire watch during and for at least 4 hours after flame-cutting operations.
 - 5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 6. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Engineer, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.05 CLEANING

- A. Remove demolition waste materials from Project Site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 4. Comply with requirements specified in Section 01 74 19 "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL."
- B. Burning: Do not burn demolished materials.
- C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Demolition*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery, and disposal, as required, as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This section includes the outline of the work for cast-in-place concrete, which includes the following:
 - 1. Cast-in-place concrete, including concrete materials, mix design, placement procedures, curing, and finishes, except as otherwise specified.
 - 2. Grout, except as otherwise specified.
 - 3. Placing of embedded anchor bolts and inserts.

1.02 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast- furnace slag, and silica fume.

1.03 SUBMITTALS

- A. All submittals shall be in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."
- B. Product Data: For each type of manufactured material and product including but not limited to the following:
 - 1. Concrete Mix.
 - 2. Admixtures.
 - 3. Curing compounds.
 - 4. Slab treatments.
 - 5. Joint-filler strips.
 - 6. Non-shrink grout.
- C. Name and address of the proposed concrete supplier.
- D. Shop Drawings: Submit shop drawings for all footings showing dimensioned locations of all construction control and expansion joints and pour sequencing. Show details for constructing construction and expansion joints, and method of keying.
- E. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances that may warrant adjustments.
- F. Delivery Tickets: With each transit truck, provide delivery ticket, signed by an authorized representative of the batch plant, containing all information required by ASTM C94, as well as time batched, type of brand of cement, cement content, maximum size of aggregate and total water content.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experience installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- C. Concrete Testing and Inspection Services: The City will engage a qualified independent testing agency to perform evaluation tests and special inspections per Structural Notes on Drawings and as required by the Code. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- E. Conduct Preinstallation Conference at the Project site.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle all material to prevent damage.
- B. Ready-mixed concrete shall be placed in its final position within 1 ½ hours after water is first added to the mixture.
- C. Mix concrete only in such quantities as are required for immediate use and use while fresh before initial set has taken place. Concrete which has developed initial set shall not be used. Concrete which has partially hardened shall not be retempered or remixed.
- D. Use all means necessary to protect cast-in-place concrete materials before, during, and after installation and to protect the installed work and material of all other trades.
- E. In the event of damage, immediately make all repairs and replacement necessary to the approval of the Engineer and at no cost to the City.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II/V – Low Alkali from one approved source.
- B. Fly Ash: ASTM C 618, Class F; except residue retained on the 45 µm (No 325) sieve shall not exceed 27 percent and the maximum loss on ignition shall not exceed 1.0 percent.
- C. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
 - 1. Nominal maximum Aggregate Size: 1-1/2 inch.
- D. Water: Potable and complying with ASTM C 94.

2.02 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride. All

admixtures are subject to Engineer's approval.

- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, types A & D or F & G.
- D. Retarding Admixture: ASTM C 494/C 494M, Type B.
- E. Chemical admixtures shall be added to the concrete during the mixing process by automatic mechanical dispensing units. These dispensers shall be calibrated periodically to ensure accuracy. On site plasticizing admixtures shall be added in accordance with manufacturer's instructions and/or recommendations.

2.03 CURING MATERIALS

- A. General: Provide concrete curing and curing and sealing compounds complying with South Coast AQMD for limitation of VOC content.
 - 1. Where access flooring is indicated, coordinate selection of curing and sealing compounds with access floor manufacturer to verify product is compatible with pedestal adhesive.
- B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- C. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- D. Water: Potable.

2.04 NON-SHRINK GROUT

- A. General: Conform to Corps of Engineers CRD-C 621, and as follows:
 - 1. Non-metallic: Master Builders "Masterflow 928", or Euclid "Euco Hi-Flow Grout", or equal, non-gas-forming and free of oxidizing catalysts and inorganic accelerators, used as dry or damp pack, or mixed to a 20-second flow (CRC-C 621), without segregation or bleeding at any temperature between 45 degrees F and 100 degrees F. Working time 30 minutes or more.
 - 2. Epoxy grout where indicated: Multi-component, premeasured, fast-curing combination of thermosetting resins and inert fillers, Master Builders "Ceilcote 648", Sikadur 42 Industrial Group-Pak by Sika Chemical Corporation, or Euclid "Euco High Strength Grout", or approved equal.

2.05 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.06 2.5 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60;
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.07 CONCRETE MIXES

- A. Concrete mixes shall be in accordance with this section unless otherwise noted on the Drawings.
- B. Mix shall be signed and sealed by a California-licensed professional engineer. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
 - 1. Proportion normal-weight concrete according to CBC Section 1905, ACI 211.1, and ACI 301.
- C. Strength of Concrete: Strengths and types of concretes shall be as indicated in the Drawings.
- D. Fly Ash: Provide the following percentages, by weight, of fly ash unless approved otherwise by the Engineer:
 - 1. Footings: 30 percent.
- E. Maximum Water-Cementitious Materials Ratio: 0.45 for all concrete unless specified or noted otherwise on the drawings.
- F. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete having an air content of 5 percent, plus or minus 1.5 percent at point of delivery.
- G. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.
- H. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- I. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - 4. Use corrosion-inhibiting admixture in concrete mixes where indicated.

2.08 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least one and one-half minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.01 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located.

3.02 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at all footing locations.

3.03 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery or during placement unless approved by Engineer. Any adding of water at the Project site, allowed by the Engineer, shall conform with the limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- E. Deposit and consolidate concrete for slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open- textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.04 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces.
- B. Flatness and Levelness: finish to the following tolerances, according to ASTM E 1155 and ACI117. Where a floor can be classified into more than one of the following categories the higher F(F) and F(L) specified shall apply:
 - 1. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17.
- C. Broom Finish: Apply a broom finish to all exposed footings, and elsewhere as indicated

3.05 MISCELLANEOUS CONCRETE ITEMS

- A. Footings: Provide footings as shown on Drawings. Set anchor bolts for anchorage at correct elevations, complying with diagrams or templates of manufacturer furnishing.

3.06 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft./hr before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of methods noted in paragraph 3.9D
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture- retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture- retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
4. Curing and Sealing Compound: Apply uniformly to floors indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.07 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.08 GROUTING

- A. Install as indicated or required. Where grouting and drypacking is part of the work of other sections, it shall conform to the following requirements, unless specified otherwise.
- B. Non-Shrink Grouting:
 1. Mixing: Mix the approved non-shrink grout material with sufficient water per manufacturer's recommendations.
 2. Application: Surfaces to receive the non-shrink grout shall be clean, and shall be moistened thoroughly immediately before placing the mortar. Before grouting, surfaces to be in contact shall be roughened and cleaned thoroughly, all loose particles shall be removed and the surface flushed thoroughly with neat cement grout immediately before the grouting mortar

is placed. Place fluid grout from one side only and puddle, chain, or pump for complete filling of voids; do not remove the dams or forms until grout attains initial set. Finish exposed surfaces smooth, and cure as recommended by grout manufacturer.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: City will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 - 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
 - a. Cast and field cure one set of four standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39; test one laboratory-cured specimens at 7 days, two at 28 days, and hold one for future testing should it be required.
 - a. Test one field-cured specimen at 7 days, two at 28 days, and hold one for future testing should it be required.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- E. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other

methods as directed by Engineer.

PART 4 - MEASUREMENT AND PAYMENT

- A. Cast-In-Place Concrete inside the building as specified herein shall be included in the measurement and payment for "Concrete". Payment shall include furnishing all forms, concrete, reinforcing, transportation, labor, materials, equipment, testing, and incidentals, as specified and shown related to the concrete footings supporting the proposed pre-manufactured crane.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Exterior non-load-bearing wall framing.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed steel framing product and accessory.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
 - 1. Expansion anchors.
 - 2. Power-actuated anchors.
 - 3. Mechanical fasteners.
 - 4. Miscellaneous structural clips and accessories.
- D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AllSteel & Gypsum Products, Inc.
 - 2. California Expanded Metal Products Company.

3. ClarkDietrich Building Systems, Inc.
4. Consolidated Fabricators Corp.; Building Products Division.
5. MarinoWARE.
6. MBA Metal Framing.
7. SCAFCO Corporation.
8. Steel Network, Inc. (The).
9. Steeler, Inc.
10. Telling Industries, LLC.
11. Approved Equal

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 1. Design Loads: As indicated on Drawings.
 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of $1/720$ of the wall height.
 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of $3/4$ inch.
 5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Design Standards:
 1. Floor and Roof Systems: AISI S210.
 2. Wall Studs: AISI S211.
 3. Headers: AISI S212.
 4. Lateral Design: AISI S213.
- D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
- E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.03 COLD-FORMED STEEL FRAMING, GENERAL

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 1. Grade: As required by structural performance.
 2. Coating: G90.

2.04 Steel EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch 18 gage.
 - 2. Flange Width: 1-5/8 inches minimum.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2.05 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Anchor clips.
 - 4. Backer plates.

2.06 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

- F. Welding Electrodes: Comply with AWS standards.

2.07 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20, Type II-Organic, and the following:
 - 1. Zinc Content: 95 percent, minimum.
 - 2. Solids: 52 percent by volume, minimum.
 - 3. Dry film thickness not less than 1.5 mils per coat.
 - 4. Color: Flat grey finish matching original hot-dipped galvanizing.
 - 5. Available Product: ZRC Cold Galvanizing Compound; ZRC Worldwide.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.
- C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.08 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding or screw fastening as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
- C. Install grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.03 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding or screw fastening. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 07 21 00 "THERMAL INSULATION," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.04 LOAD-BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 1. Anchor Spacing: As shown on Shop Drawings.
- B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 1. Stud Spacing: 16 inches unless otherwise indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
 2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- I. Install horizontal bridging in stud system, spaced vertically as indicated on Shop Drawings. Fasten at each stud intersection.
 1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
- J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.05 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 16 inches unless otherwise indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to bypassing or infill studs and anchor to building structure.
 - 4. Connect drift clips to cold-formed metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - a. Install solid blocking at centers indicated.
 - 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.06 INSTALLATION TOLERANCES

- A. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:
 - 1. Layout of walls and partitions: 6 mm 1/4 inch from intended position;
 - 2. Plates and runners: 6 mm in 2400 mm 1/4 inch in 8 feet from a straight line;
 - 3. Studs: 6 mm in 2400 mm 1/4 inch in 8 feet out of plumb, not cumulative; and
 - 4. Face of framing members: 6 mm in 2400 mm 1/4 inch in 8 feet from a true plane.

3.07 FIELD QUALITY CONTROL

- A. Testing: The City will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and the Engineer.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.08 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

PART 4 - MEASUREMENT AND PAYMENT

- A. Cold-Formed Metal Framing as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Miscellaneous framing and supports.
 - 2. Metal bollards.
 - 3. Loose bearing and leveling plates.
 - 4. Wire Mesh Partition and Gate.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.02 DEFINITIONS

- A. SSPC: Society for Protective Coatings (SSPC) is a professional association for the industrial and marine coatings, founded in 1950 as the Steel Structures Painting Council, a non-profit association.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Fasteners.
 - 2. Manufactured metal ladders.
 - 3. Metal bollards.
 - 4. Wire Mesh Partition and Gate.
- B. Shop Drawings: Show fabrication and installation details.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Aluminum Ladders: Ladders, including crossovers, handrails and landings, are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

2.02 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- D. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- G. Zinc-Coated Steel Wire Rope: ASTM A741.
 - 1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- H. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: As indicated.
 - 2. Material: Galvanized steel, ASTM A653/A653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108-inch (2.8-mm) nominal thickness.
- I. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T6.
- J. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

2.03 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum.
 - 2. Provide bronze fasteners for fastening bronze.
- B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- C. Post-Installed Anchors: Torque-controlled expansion anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593 (ISO 3506-1), and nuts, ASTM F594 (ASTM F836M).
- D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.04 MISCELLANEOUS MATERIALS

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

- B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Concrete: Comply with requirements in Section 03 30 00 "CAST-IN-PLACE CONCRETE" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.05 FABRICATION - GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.06 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.07 METAL FLOOR PLATE

- A. Fabricate from rolled-steel floor plate of thickness indicated below:
 - 1. Thickness: As indicated.
- B. Provide steel angle supports as indicated.

2.08 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Galvanize exterior miscellaneous steel trim.

2.09 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe, concrete filled with domed top.
- B. Prime steel bollards with zinc-rich primer. Polyurethane finish coat.

2.10 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.
- C. Prime plates with zinc-rich primer.

2.11 STEEL MESH PARTITIONS AND GATE

- A. As indicated on Drawings, custom fabricated, with heavy duty gate, Door Hardware as scheduled on Drawings.

2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer unless indicated.

- C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." or SSPC-SP 3, "Power Tool Cleaning."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for securely to, and rigidly brace from, building structure.

3.03 INSTALLATION OF MISCELLANEOUS STEEL TRIM

- A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.04 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
 - 1. Embed anchor bolts at least 4 inches (100 mm) in concrete.
- C. Anchor bollards in concrete. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.
- D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- E. Fill bollards solidly with concrete, mounding top surface to shed water.

3.05 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.06 WIRE MESH PARTITION MODIFICATIONS

- A. Attachment fabrications and modifications to reinstall the existing wire partition the new configuration as indicated on Drawings.

3.07 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

PART 4 - MEASUREMENT AND PAYMENT

- A. Metal Fabrications as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Wood blocking and nailers.
 - 2. Plywood backing panels.

1.02 DEFINITIONS

- A. Preservative Treatment: Infusion of mineral or chemical treatment into the pores of the wood to enhance resistance to organic decay.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of process and factory-fabricated product.
 - 2. For preservative-treated wood products.

1.04 INFORMATIONAL SUBMITTALS

- A. Material Certificates:
 - 1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
 - 2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.
 - 2. Fire-retardant-treated wood.
 - 3. Power-driven fasteners.
 - 4. Post-installed anchors.
 - 5. Metal framing anchors.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

- A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency

certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:

1. Boards: 19 percent.
2. Dimension Lumber: 19 percent unless otherwise indicated.

2.02 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.03 FIRE-RETARDANT-TREATMENT

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.

2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat items indicated on Drawings, and the following:
 1. Plywood backing panels.

2.04 DIMENSION LUMBER FRAMING

- A. Framing Other Than Non-Load-Bearing Partitions by Grade: Construction or No. 2 grade.
 1. Application: Roof Framing and other incidental applications.
 2. Species:
 - a. Hem-fir (north); NLGA.
 - b. Southern pine; SPIB.
 - c. Douglas fir-larch; WCLIB or WWPA.
 - d. Southern pine or mixed southern pine; SPIB.
 - e. Spruce-pine-fir; NLGA.
 - f. Douglas fir-south; WWPA.
 - g. Hem-fir; WCLIB or WWPA.
 - h. Douglas fir-larch (north); NLGA.
 - i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
- B. Exposed Framing: Hand-select material for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 1. Species and Grade: As indicated above for load-bearing construction of same type.

2.05 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:
 1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
 2. Eastern softwoods; No. 2 Common grade; NeLMA.
 3. Northern species; No. 2 Common grade; NLGA.
 4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.06 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.07 FASTENERS

- A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

2.08 METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cleveland Steel Specialty Co.
 - 2. MiTek Industries, Inc.
 - 3. Phoenix Metal Products, Inc.
 - 4. Simpson Strong-Tie Co., Inc.
 - 5. Tamlyn.
 - 6. Approved Equal.
- B. Allowable design loads, as published by manufacturer, are to meet or exceed those of products of manufacturers listed. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors are to be punched for fasteners adequate to withstand same loads as framing anchors.
- C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 (Z180) coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for wood-preservative-treated lumber and where indicated.

2.09 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- C. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- D. Install shear wall panels to comply with manufacturer's written instructions.
- E. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Do not splice structural members between supports unless otherwise indicated.
- G. Comply with AWPAC M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.

3.02 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

PART 4 - MEASUREMENT AND PAYMENT

- A. Rough Carpentry as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 06 41 16

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-faced architectural shelves/cabinets and countertops.

1.02 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings: For plastic-laminate-faced architectural cabinets.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show large-scale details.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of product.
- B. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.07 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.08 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be supported and installed as indicated.

PART 2 - PRODUCTS

2.01 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Grade: Custom.
- C. Type of Construction: Frameless.

- D. Door and Drawer-Front Style: Flush overlay.
 - 1. Reveal Dimension: 1/2 inch or as indicated.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
 - 1. Manufacturers: Provide products of one the following:
 - a. Abet Laminati, Inc.
 - b. Formica Corporation.
 - c. Lamin-Art, Inc.
 - d. Pionite; Panolam Industries International, Inc.
 - e. Wilsonart LLC.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Vertical Surfaces: Grade HGS or Grade VGS.
 - 3. Edges: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
 - 4. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels unless otherwise indicated.
- G. Materials for Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - 2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
 - 3. Drawer Bottoms: Thermoset decorative panels.
- H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

2.02 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content:
 - a. 5 to 10 percent for most applications.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Recycled Content of MDF: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
 - 2. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.

3. Softwood Plywood: DOC PS 1, medium-density overlay.
 - a. Wet Areas: Marine grade plywood; APA A-B Marine Grade, medium density overlay.
4. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.03 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Subject to compliance with requirements, provide product indicated on the Finish Legend and details in the Drawings or comparable product by one of the following
 1. Blum
 2. Hafele
 3. Master
 4. Mockett
- C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.
- D. Pulls: Provide the following, unless otherwise indicated on the Drawings:
 1. Basis of Design Product: "DP3A-26D Series" as manufactured by Doug Mockett & Company, Inc.; satin chrome finish.
 - a. Length: 3 inches.
- E. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- F. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip].
- G. Door and Drawer Silencers: BHMA A156.16, L03011.
- H. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 1. Color: Black.
- I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base unless other finish is indicated.
- J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.04 PLASTIC-LAMINATE COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.
- B. Grade: Custom.

- C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.
- D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As selected by the Engineer from manufacturer's full range in the following categories:
 - a. Wood grains, matte finish.
 - b. Patterns, matte finish.
 - 2. Grain Direction: Parallel to cabinet fronts.
- E. Edge Treatment: 3-mm PVC edging.
- F. Core Material: Medium-density fiberboard made with exterior glue.
- G. Core Material at Sinks: medium-density fiberboard made with exterior glue.
- H. Core Thickness: 3/4 inch.
 - 1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.
- I. Paper Backing: Provide paper backing on underside of countertop substrate or urethane seal coat.

2.05 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Adhesives: Do not use adhesives that contain urea formaldehyde
- E. Adhesive for Bonding Plastic Laminate: Contact cement.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.06 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check

measurements of assemblies against field measurements before disassembling for shipment.

- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- D. Install glass to comply with applicable requirements in GANA's "Glazing Manual."
 - 1. For glass in frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.02 INSTALLATION

- A. Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 3. Fasten wall cabinets with continuous hanging cleats near top and bottom.

3.03 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Remove adhesives, sealants, and other stains.
- C. Clean, lubricate, and adjust hardware.
- D. Clean cabinets on exposed and semiexposed surfaces.

- E. Touch up shop-applied finishes to restore damaged or soiled areas.

PART 4 - MEASUREMENT AND PAYMENT

- A. Plastic-Laminate-Clad Architectural Cabinets as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Glass-fiber blanket.
 - 2. Glass-fiber board.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

- 2.01** Refer to Drawings for thickness and R-values and Energy Code prescriptive requirements to be complied with.

2.02 ISOci - POLYISOCYANURATE FOAM-PLASTIC BOARD CONTINUOUS INSULATION

2.03 GLASS-FIBER BLANKET

- A. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville; a Berkshire Hathaway company.

3. Knauf Insulation.
 4. Owens Corning.
 5. Approved Equal.
- C. Glass-Fiber Blanket, Unfaced: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

2.04 GLASS-FIBER BOARD

- A. Insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CertainTeed Corporation.
 2. Johns Manville; a Berkshire Hathaway company.
 3. Knauf Insulation.
 4. Owens Corning.
 5. Approved Equal.
- C. Basis of Design Product: Owens Corning Type 703
- D. Glass-Fiber Board, Faced: ASTM C 612, Type IA; faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84. Nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.
- E. Glass-Fiber Board, Unfaced: ASTM C 612, Type IA; unfaced, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84, passing ASTM E 136 for combustion characteristics. Nominal density of 4.25 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.05 PHENOLIC INSULATION

- A. Not allowed.

2.06 INSULATION FASTENERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AGM Industries, Inc.
 2. Gemco.
 3. Approved Equal.
- B. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle for horizontal underdeck application; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

- C. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors for horizontal underdeck application: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 - 1. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
 - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
- D. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
 - 1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Attic spaces.
- E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.07 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
 - 2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
 - 1. Adhesives shall have a VOC content of 70 g/L or less.
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.03 INSTALLATION OF UNDER DECK INSULATION

- A. On horizontal surfaces, attach insulation units according to manufacturer's written instructions with adhesive and mechanical attachment. Stagger end joints and tightly abut insulation units.

3.04 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.05 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Thermal and Moisture Protection*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 07 21 19
FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Closed-cell spray polyurethane foam.

1.02 DEFINITIONS

- A. A reactive fluid that rapidly expands and cures into a rigid insulation with excellent insulative, adhesive and void filling properties.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Research reports.

PART 2 - PRODUCTS

2.01 CLOSED-CELL SPRAY POLYURETHANE FOAM

- A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 1.5 lb/cu. ft. (24 kg/cu. m) and minimum aged R-value at 1-inch (25.4-mm) thickness of 6.2 deg F x h x sq. ft./Btu at 75 deg F (25 mm of 43 K x sq. m/W at 24 deg C).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Spray Foam Insulation.
 - b. Gaco; a brand of Firestone Building Products.
 - c. Henry Company.
 - d. Huntsman Building Solutions.
 - e. Johns Manville; a Berkshire Hathaway company.
 - f. Master Builders Solutions.
 - g. NCFI Polyurethanes; a division of Barnhardt Manufacturing Company.
 - h. SES Foam LLC.
 - i. SWD Urethane Company.
 - j. Volatile Free, Inc.
 - k. Approved Equal.

2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
3. Fire Propagation Characteristics: Passes NFPA 285 (exterior walls) testing as part of an approved assembly.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Spray insulation to envelop entire area to be insulated and fill voids.
- C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.

PART 4 - MEASUREMENT AND PAYMENT

- A. Foamed-In-Place as specified herein shall be included in the measurement and payment for "Thermal and Moisture Protection".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 07 42 13.13
FORMED METAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Concealed-fastener, lap-seam metal wall panels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 3 inches per 12 inches (1:5).
- C. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
 - 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in architectural sheet metal products.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Remove strippable protective covering on metal panels during installation. Do not leave film on installed panels.

1.07 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.08 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.09 WARRANTY

- A. Special Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing or perforating.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: 20 years and six months from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, chipping, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 29 percent.

2.02 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. General: Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
- B. Box-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, box-shaped ribs, evenly spaced across panel width, and with rib/recess sides angled 70 degrees or more.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Petersen Aluminum Corporation; Precision Series Box Rib 1 with clip or a comparable product by one of the following:
 - a. CENTRIA Architectural Systems.
 - b. Exceptional Metals.
 - c. MBCI; a division of NCI Group, Inc.
 - d. McElroy Metal, Inc.
 - e. Metal Sales Manufacturing Corporation.
 - f. MetlSpan.
 - g. Morin; a Kingspan Group company.
 - h. Petersen Aluminum Corporation.
 - 2. Aluminum Sheet: Coil-coated sheet, ASTM B209 (ASTM B209M), Alloy 3105, with H14 temper as required to suit forming operations and structural performance required.
 - a. Thickness: 0.040 inch (1.02 mm).
 - b. Surface: Smooth, flat finish.
 - c. Exterior Finish: Metallic fluoropolymer to match existing.
 - d. Color: to match existing.
 - 3. Major-Rib Spacing: 2 inches (50 mm) o.c.
 - 4. Panel Coverage: 12 inches (305 mm).
 - 5. Panel Height 1.25 inches (32 mm)

2.03 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.02 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grace Ultra
 - b. Mid-States Asphalt Quick Stick HT Pro
 - c. Polyglass Polystick MTS
 - d. Soprema Lastobond Shield HT
 - e. Tamko TW Underlayment or TW Metal & Tile Underlayment
 - f. Approved Equal.
 - 2. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970.

3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D1970.

2.04 MISCELLANEOUS MATERIALS

- A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- D. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.05 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs for full length of panel.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.06 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
 1. Metallic Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on continuous coil coating line, with top-side dry film thickness of 0.75 ± 0.05 mil (0.019 ± 0.0013 mm) over 0.2 ± 0.05 -mil (0.05 ± 0.0013 -mm) primer coat, to provide total dry film thickness of 0.95 ± 0.10 mil (0.024 ± 0.0025 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Match existing building finishes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

- a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal panel manufacturer's written instructions.

3.03 METAL PANEL INSTALLATION

- A. General: Install metal panels in accordance with manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
 - 1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use stainless steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Watertight Installation:
 - 1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
 - 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - 3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

- E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
 - 1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.04 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

PART 4 - MEASUREMENT AND PAYMENT

- A. Formed Metal Wall Panels as specified herein shall be included in the measurement and payment for "Thermal and Moisture Protection".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 07 72 00

ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Roof curbs.
 - 2. Pipe portals.
 - 3. Patching of existing roof membrane.

1.02 DEFINITIONS

- A. Roof accessories: Manufactured components that interface with but are not an integral component of the roofing system.

1.03 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.

- 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.07 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.02 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adaptable Air Products.
 - b. AES Industries, Inc.
 - c. Air Balance; a division of MESTEK, Inc.
 - d. Conn-Fab Sales, Inc.
 - e. Curbs Plus, Inc.
 - f. Custom Solution Roof and Metal Products.
 - g. Greenheck Fan Corporation.
 - h. KCC International Inc.
 - i. Kingspan Light + Air, North America.
 - j. Lloyd Industries, Inc.
 - k. LMCurbs.

- l. Louvers & Dampers, Inc.; a division of Mestek, Inc.
 - m. Metallic Products Corp.
 - n. Milcor; Commercial Products Group of Hart & Cooley, Inc.
 - o. Pate Company (The).
 - p. Plenums Incorporated.
 - q. Roof Curb Systems.
 - r. Roof Products and Systems (RPS); a division of Hart & Cooley, Inc.
 - s. Roof Products, Inc.
 - t. Thybar Corporation.
 - u. Vent Products Co., Inc.
 - v. Approved Equal.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.
- D. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.079 inch thick.
- 1. Finish: Two-coat fluoropolymer or Baked enamel or powder coat.
 - 2. Color: As selected by the Engineer from manufacturer's full range.
- E. Material: Aluminum sheet, 0.125 inch thick.
- 1. Finish: Two-coat fluoropolymer or Baked enamel or powder coat.
 - 2. Color: As selected by the Engineer from manufacturer's full range.
- F. Material: Stainless steel sheet, 0.078 inch thick.
- 1. Finish: Manufacturer's standard.
- G. Construction:
- 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - 4. Top Surface: Level top of curb, with roof slope.
 - 5. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
 - 6. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 7. Nailer: Factory-installed wood nailer.
 - 8. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 9. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.03 PIPE PORTALS

- A. Curb-Mounted Pipe Portal: Insulated roof-curb units with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom; with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Roof Products and Systems (RPS); a division of Hart & Cooley, Inc.
 - b. Approved Equal
- B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Roof Products and Systems (RPS); a division of Hart & Cooley, Inc.
 - b. Approved Equal

2.04 METAL MATERIALS

- A. Stainless Steel Sheet: ASTM A240/A240M, Type 304 or Type 316, dead soft, fully annealed; with smooth, flat surface.
 1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).
- B. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

2.05 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.
- C. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- D. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- F. Underlayment:

1. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
2. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 3. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
 4. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 5. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

2.06 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.

2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Existing Roof Membrane and Roof Insulation:
1. Cut existing roof deck and insulation from underside to fit penetration sleeve, coordinated with support framing.
 2. Cut roof membrane in a manner to minimize patching.
 3. Install units in accordance with manufacturer's written instructions and infill all perimeter roof deck and insulation voids with closed-cell spray foam insulation.
 4. Install 1/2 inch in 12 crickets as required for proper drainage.
 5. Roll back and adhere existing roof membrane around new penetration to insulation.
 6. Match existing roof membrane with new flashings in accordance with roof manufacturer's written installation and warranty requirements. Provide documentation on the continued warranty.
- C. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- D. Roof Curb Installation: Install each roof curb so top surface is level.
- E. Preformed Flashing-Sleeve and Flashing Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.
- F. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.03 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 13 "EXTERIOR PAINTING."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

PART 4 - MEASUREMENT AND PAYMENT

- A. Roof Accessories as specified herein shall be included in the measurement and payment for "Thermal and Moisture Protection".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 07 84 13
PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Meeting: Conduct Meeting at Project Site.

1.03 ACTION SUBMITTALS

- A. Product data: For each type of product.
- B. Product Schedule: For each penetration firestopping system, include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.04 INFORMATIONAL SUBMITTALS

- A. Listed system designs – see Article 2.02, herein.

1.05 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
 - 3) FM Approvals in its "Approval Guide."

2.02 PENETRATION FIRESTOPPING SYSTEMS

- A. Description: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - a. Those within the cavity of a wall.
 - b. Floor, tub, or shower drains within a concealed space.
 - c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined in accordance with UL 1479.
 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, in accordance with ASTM E84.
- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- D. Install fill materials by proven techniques to produce the following results:
 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.02 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.03 FIELD QUALITY CONTROL

- A. The City will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

PART 4 - MEASUREMENT AND PAYMENT

- A. Penetration Firestopping as specified herein shall be included in the measurement and payment for "Thermal and Moisture Protection".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Latex joint sealants.

1.02 DEFINITIONS

- A. Joint sealants are used to seal joints and openings (gaps) between two or more substrates, to prevent air, water, and other environmental elements from entering or exiting a structure while permitting limited movement of the substrates.

1.03 ACTION SUBMITTALS

- A. Product data: For each type of product.
- B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Joint-sealant schedule.
- D. Sustainable Design Submittals:
 - 1. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.04 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.
- B. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.07 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by the Engineer from manufacturer's full range.

2.02 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adfast.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. Pecora Corporation.
 - d. Sika Corporation - Building Components.
 - e. The Dow Chemical Company.
 - f. Approved Equal.

- B. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Soudal USA.
 - b. The Dow Chemical Company.
 - c. Approved Equal.
- C. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. The Dow Chemical Company.
 - b. Approved Equal.

2.03 URETHANE JOINT SEALANTS

- A. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Master Builders Solutions.
 - b. Pecora Corporation.
 - c. Polymeric Systems, Inc.
 - d. Sherwin-Williams Company (The).
 - e. Approved Equal.

2.04 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adfast.
 - b. Everkem Diversified Products, Inc.
 - c. Franklin International.
 - d. Pecora Corporation.
 - e. Sherwin-Williams Company (The).
 - f. Tremco Incorporated.
 - g. Approved Equal

2.05 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adfast.
 - b. Alcot Plastics Ltd.
 - c. Construction Foam Products; a division of Nomaco, Inc.
 - d. Master Builders Solutions.
 - e. Approved Equal

- B. Rodent protected wall penetrations: coarse stainless steel wool or copper wool backing embedded in gray silicone:
- C. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to

comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
 - 4. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage

or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

- I. Rodent protected wall penetrations: coarse stainless steel wool or copper wool backing embedded in gray silicone:
 1. The depth of the silicone-saturated steel wool joint should never be less than the annular space dimension. Voids between the interior seal and exterior seal should be filled with steel or copper wool.
 2. Tape off perimeter of opening leaving 1/4-inch of the siding exposed.
 3. For large annular spaces use backer rod as temporary interior backing and seal perimeter edges and crevices with gray silicone.
 4. Fill annular space with coarse steel wool recessed to 1/3 of depth,
 5. Inject gray silicone into the steel wool and perimeter edges and crevices as deeply as possible, then completely coat over that with an additional layer of silicone sealing all edges.
 6. Press and tool another layer of coarse steel wool into wet silicone to flush and inject silicone into the wool fully.
 7. Let the silicone initial cure, then trim off any protruding wool.
 8. Apply finish coat of silicone to completely seal the stainless steel or copper wool and provide a smooth weather resistant surface. Remove tape during or immediately following the silicone initial set.
 9. Interior: repeat the above process.

PART 4 - MEASUREMENT AND PAYMENT

- A. Joint Sealants as specified herein shall be included in the measurement and payment for "Thermal and Moisture Protection".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Exterior standard steel doors and frames.
 - 2. Interior Window Frames

1.02 DEFINITIONS

- A. HM Doors and Frames: Fabricated from cold formed steel sheet faces and various core materials, designed for strength and durability.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door and window type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.04 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Field quality control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.06 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1.

- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Airtec Corporation.
 2. Apex Industries, Inc.
 3. BARON Metal Industries, Inc.; ASSA ABLOY of Canada, Ltd.; ASSA ABLOY.
 4. Ceco Door; AADG, Inc.; ASSA ABLOY.
 5. Concept Frames, AADG, Inc.; ASSA ABLOY Group.
 6. Curries, AADG, Inc.; ASSA ABLOY Group.
 7. Custom Metal Products.
 8. DCI Hollow Metal on Demand.
 9. DE LA FONTAINE.
 10. Daybar Industries, Ltd.
 11. Deansteel Manufacturing Company, Inc.
 12. Deronde Products.
 13. National Custom Hollow Metal Doors & Frames.
 14. North American Door Corp.
 15. Philipp Manufacturing Co (The).
 16. Pioneer Industries; AADG, Inc.; ASSA ABLOY.
 17. Premier Products, Inc.
 18. Republic Doors and Frames; a Allegion brand.
 19. Rocky Mountain Metals, Inc.
 20. Security Metal Products; a brand of ASSA ABLOY.
 21. Steelcraft; Allegion plc.
 22. Steward Steel, Door & Frame Division.
 23. Stiles Custom Metal, Inc.
 24. Titan Metal Products.
 25. Trillium Steel Doors Limited.
 26. West Central Manufacturing, Inc.
 27. Approved Equal.

2.02 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
 - d. Edge Construction: Model 2, Seamless.

- e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- f. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- g. Core: Polyurethane Vertical steel stiffener.
- 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
 - b. Construction: Full profile welded.

2.03 WINDOW FRAMES

- A. Match door frame material, construction and profiles.
- B. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- C. Glazing.
 - 1. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear)
 - 2. Glass Type GL55: Clear, fully-tempered float glass.
 - a. Thickness: 1/4 inch.
 - b. Provide safety glazing labeling.
 - 3. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 4. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - a. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.04 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
 - 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.05 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Polyurethane Foam, closed cell.

2.06 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.07 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

- A. Hollow-Metal Frames: Comply with NAAMM-HMMA 840.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - 2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
 - 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 4. Solidly pack mineral-fiber insulation inside frames or inject with polyurethane foam.
 - 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - 6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 - 1. Non-Fire-Rated Steel Doors: Comply with NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.

3.03 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

PART 4 - MEASUREMENT AND PAYMENT

- A. Hollow Metal Doors and Frames as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

GENERAL SECTION 08 41 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Aluminum-framed storefront systems.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Meeting: Conduct meeting at Project Site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples: For each type of exposed finish required.

1.04 INFORMATIONAL SUBMITTALS

- A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
- B. Product test reports.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Installers: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by the Engineer, except with the Engineer's approval. If changes are proposed, submit comprehensive explanatory data to the Engineer for review and approval.

1.07 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

- a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- B. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
- C. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
 - 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Limited to $2L/175$ at unsupported cantilevers.
- D. Structural: Test in accordance with ASTM E330/E330M as follows:
 - 1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- E. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
- F. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
 - 1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.34 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 - b. Entrance Doors: U-factor of not more than 0.593 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 - 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.34 as determined in accordance with NFRC 200.

- b. Entrance Doors: SHGC of not more than 0.24 as determined in accordance with NFRC 200.
- 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft. when tested in accordance with ASTM E283.
 - b. Entrance Doors: Air leakage of not more than Insert value at a static-air-pressure differential of 1.57 lbf/sq. ft..
- 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined in accordance with AAMA 1503.
 - b. Entrance Doors: CRF of not less than 63 as determined in accordance with AAMA 1503.
- 5. VT: 0.40 for doors and 0.62 for fixed.
- G. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 3 for basic protection.
 - 1. Large-Missile Test: For glazing located within 30 feet of grade.
 - 2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.
- H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 STOREFRONT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arcadia, Inc.
 - 2. Avanti Systems USA.
 - 3. Boyd Aluminum Mfg. Co.
 - 4. CMI Architectural Products, Inc.
 - 5. Commercial Architectural Products, Inc.
 - 6. Coral Architectural Products; Coral Industries, Inc.
 - 7. EFCO Corporation.
 - 8. Kawneer Company, Inc.; Arconic Corporation.
 - 9. Leed Himmel Industries, Inc.
 - 10. Manko Window Systems, Inc.
 - 11. Oldcastle BuildingEnvelope (OBE); CRH Americas, Inc.
 - 12. Pittco Architectural Metals, Inc.
 - 13. Trulite Glass & Aluminum Solutions, LLC.
 - 14. Tubelite Inc.
 - 15. U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.
 - 16. YKK AP America Inc.
 - 17. Approved Equal.

- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Exterior Framing Construction: Thermally broken.
 - 2. Interior Vestibule Framing Construction: Nonthermal.
 - 3. Glazing System: Retained mechanically with gaskets on four sides.
 - 4. Finish: Three coat PVDF 70%.
 - 5. Fabrication Method: Field-fabricated stick system.
 - 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 7. Steel Reinforcement: As required by manufacturer.
- C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.03 GLAZING

- A. Glazing: Match exiting building glazing.
 - 1. Product: IGUViracon VE1-2M
 - 2. Construction 1/4 inch, 1/2 inch air, 1/4 inch clear annealed
 - 3. VLT % 70
 - 4. UVW 0.29
 - 5. UVS 0.26
 - 6. SC 0.44
 - 7. SHGC 0.38
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.04 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.

2.05 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from exterior.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.06 ALUMINUM FINISHES

- A. Match existing building finishes.
- B. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: As selected by the Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 07 92 00 "JOINT SEALANTS," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

PART 4 - MEASUREMENT AND PAYMENT

- A. Aluminum Framed Storefront as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies commercial door hardware for the following:
 - 1. Swinging doors.
- B. Commercial door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.

1.02 DEFINITIONS

- A. Door hardware: Door accessory components that facilitate controlled operation of doors.

1.03 REFERENCES

- A. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.

- b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
- 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the City, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. City to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in 01 70 00 "EXECUTION AND CLOSEOUT REQUIREMENTS". The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in the Related Sections.

1.05 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum 3 years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor and the Engineer concerning both standard and electromechanical door hardware and keying.

- D. Source Limitations: Obtain each type and variety of Door Hardware specified in the Related Sections from a single source, qualified supplier unless otherwise indicated.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the applicable model building code.
- F. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in 01 31 19 "PROJECT MEETINGS" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project Site. Do not store electronic access control hardware, software or accessories at Project Site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to City via registered mail or overnight package service. Instructions for delivery to the City shall be established at the "Keying Conference".

1.07 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.08 WARRANTY

- A. General Warranty: Reference GC-3.5.1 - Warranty. Special warranties specified in this Article shall not deprive City of other rights City may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.09 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for City's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

- A. Refer to Drawings for hardware schedule.

PART 3 - EXECUTION

3.01 DOOR HARDWARE SETS

- A. The door hardware sets represent the design intent and direction of the Engineer. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the Engineer with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
 - 1. Hardware Quantities listed are for each pair of doors, or for each single door.
 - 2. The supplier is responsible for handing and sizing all products.
 - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
- B. Products listed in the hardware sets on the Drawings shall be supplied by and in accordance with the requirements of this Section as noted for each item.

PART 4 - MEASUREMENT AND PAYMENT

- A. Door Hardware as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.

1.02 DEFINITIONS

- A. Non-Structural Metal Framing: Light Gage framing for walls, soffits and partitions not subject to imposed loading beyond the assembly.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.04 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For firestop tracks post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.05 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For non-composite wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).
 - 1. Verify spans, gage and bracing requirements of studs indicated in Wall Type descriptions in Drawings using the span charts in the 2014 Steel Stud Manufacturer's Association (SSMA) "Product_Technical_Catalog."
 - 2. Reduced thickness embossed studs are not allowed.

2.02 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
 - 2. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C645. Conventional steel studs and tracks.
 - 1. Steel Studs and Tracks:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) CEMCO; California Expanded Metal Products Co.
 - 2) ClarkDietrich Building Systems.
 - 3) MarinoWARE.
 - 4) MBA Building Supplies.
 - 5) MRI Steel Framing, LLC.
 - 6) Phillips Manufacturing Co.
 - 7) Steel Network, Inc. (The).
 - 8) Telling Industries.
 - 9) Approved Equal.
 - b. Minimum Base-Steel Thickness: As indicated on Drawings and as required by performance requirements for horizontal deflection 0.0329 inch (0.836 mm) and required by span charts.
 - c. Depth: As indicated on Drawings.
- C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ClarkDietrich Building Systems.
 - b. MRI Steel Framing, LLC.
 - c. Approved Equal.
 - 2. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
- D. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ClarkDietrich Building Systems.
 - b. MRI Steel Framing, LLC.
 - c. Approved Equal.
 - 2. Depth: As indicated on Drawings.
 - 3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

- E. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ClarkDietrich Building Systems.
 - b. MRI Steel Framing, LLC.
 - c. Approved Equal.
 - 2. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - 3. Depth: As indicated on Drawings.
- F. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ClarkDietrich Building Systems.
 - b. MRI Steel Framing, LLC.
 - c. Approved Equal.
 - 2. Configuration: Asymmetrical or hat shaped.
- G. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: As indicated on Drawings.
 - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 - 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-steel thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ClarkDietrich Building Systems.
 - b. MRI Steel Framing, LLC.
 - c. Approved Equal.

2.03 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLATION TOLERANCES

- A. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:
 - 1. Layout of walls and partitions: 6 mm 1/4 inch from intended position.
 - 2. Plates and runners: 6 mm in 2400 mm 1/4 inch in 8 feet from a straight line;
 - 3. Studs: 6 mm in 2400 mm 1/4 inch in 8 feet out of plumb, not cumulative; and
 - 4. Face of framing members: 6 mm in 2400 mm 1/4 inch in 8 feet from a true plane.
- B. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:
 - 1. Layout of walls and partitions: 6 mm 1/4 inch from intended position;
 - 2. Plates and runners: 3 mm in 2400 mm 1/8 inch in 8 feet from a straight line;
 - 3. Studs: 3 mm in 2400 mm 1/8 inch in 8 feet out of plumb, not cumulative; and

4. Face of framing members: 3 mm in 2400 mm 1/8 inch in 8 feet from a true plane.

3.05 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 2. Multilayer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 3. Tile Backing Panels: As required by horizontal deflection performance requirements unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 1. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 2. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 3. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- E. Direct Furring:
 1. Screw to wood framing.
 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- F. Z-Shaped Furring Members:
 1. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
 2. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Interior Build-Out*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Interior mold and mildew resistant gypsum board.
 - 2. Exterior gypsum sheathing for exterior walls.

1.02 DEFINITIONS

- A. Gypsum Board: A faced processed gypsum filled sheet product that is used for facing walls and ceilings and partitions, known for fire resistance and finish qualities.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
 - 2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.
- C. Samples for Verification: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.05 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Ceiling and wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.02 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 INTERIOR GYPSUM BOARD

- A. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
 1. Basis of Design Products: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. CertainTeed Gypsum.
 - d. Continental Building Products, LLC.
 - e. Georgia-Pacific Gypsum LLC.
 - f. National Gypsum Company.
 - g. PABCO Gypsum.
 - h. USG Corporation.
 - i. Approved Equal
 2. Core: Thickness and Fire Rating as indicated on Wall Types in Drawings.
 3. Long Edges: Tapered.
 4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.04 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

- A. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
 1. Basis of Design Products: Subject to compliance with requirements, provide Basis of Design or products by one of the following:

- a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Continental Building Products, LLC.
 - d. Georgia-Pacific Gypsum LLC.
 - e. National Gypsum Company.
 - f. USG Corporation.
 - g. Approved Equal
2. Core: Thickness and Fire Rating as indicated on Wall Types in Drawings.

2.05 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
- 1. Basis of Design Products: Subject to compliance with requirements, provide Basis of Design or products by one of the following:
 - a. CertainTeed Corp.; GlasRoc Tile Backer.
 - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
 - c. National Gypsum Company; e2XP Tile Backer.
 - d. USG Corporation.
 - e. Approved Equal
 - 2. Core: Thickness and Fire Rating as indicated on Wall Types in Drawings.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- B. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.
- 1. Basis of Design Products: Subject to compliance with requirements, provide Basis of Design or products by one of the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. CertainTeed Gypsum.
 - d. Continental Building Products, LLC.
 - e. Georgia-Pacific Gypsum LLC.
 - f. National Gypsum Company.
 - g. PABCO Gypsum.
 - h. USG Corporation.
 - i. Approved Equal
 - 2. Core: Thickness and Fire Rating as indicated on Wall Types in Drawings.

2.06 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
- 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet or.
 - 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.

- B. Exterior Trim: ASTM C1047.
 - 1. Material: Hot-dip galvanized-steel sheet, plastic, or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
- C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 - 1. Basis of Design Products: Subject to compliance with requirements, provide Basis of Design or products by one of the following:
 - a. Flannery, Inc.
 - b. Fry Reglet Corporation.
 - c. Gordon, Inc.
 - d. Pittcon Industries.
 - e. Tamlyn.
 - f. Approved Equal
 - 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221 (ASTM B221M), Alloy 6063-T5.
 - 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified or Class II anodic finish.

2.07 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Exterior Gypsum Soffit Board: Paper.
 - 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 - 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Exterior Applications:
 - 1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
 - 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

2.08 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
 - 2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 - 2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.
 - 1. Basis of Design Products: Subject to compliance with requirements, provide Basis of Design or products by one of the following:
 - a. Accumetric LLC.
 - b. Everkem Diversified Products, Inc.
 - c. Franklin International.
 - d. Grabber Construction Products.
 - e. Hilti, Inc.
 - f. Pecora Corporation.
 - g. Specified Technologies, Inc.
 - h. USG Corporation.
 - i. Approved Equal
 - 2. Sealant shall have a VOC content of 250 g/L or less.
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels. Install joints according to ASTM C840 at locations indicated on Drawings and as below:
 - 1. Above all interior doors install a vertical wall control joints with aligned with jamb.
 - a. Area of interior walls between control joints not to exceed 900 sqft or 30 feet between joints. Refer to Drawings to confirm where specific locations are required.
 - b. Above both jambs on sliding doors, full glazed openings, or hinged door widths over 42 inches.
 - c. Above hinge jamb only on typical hinged doors of 42 inches or less.
 - d. Above openings with hinge jamb within 24 inches of a wall intersection; install above strike jamb.
 - 2. At interior window frames install vertical wall Provide additional control joints where indicated on Drawings.
 - 3. Align the joint to the outside face of door trim where it overlaps the wall surface.
 - 4. Align the joint to the cornerbead of punched openings with inset jambs.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.03 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 1. Wallboard Type: Vertical unless otherwise indicated on Wall Types in Drawings.
 2. Type X: as indicated on Wall Types in Drawings.
 3. Mold-Resistant Type: as indicated on Wall Types in Drawings.
 4. Glass-Mat Interior Type: as indicated on Wall Types in Drawings.
- B. Single-Layer Application:
 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) on metal studs, horizontally (perpendicular to framing) on wood studs unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer

- joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.
- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.04 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C840 and in specific locations approved by the Engineer for visual effect.
- C. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. Bullnose Bead: Use at outside corners.
 3. LC-Bead: Use at exposed panel edges.
 4. L-Bead: Use where indicated.
 5. U-Bead: Use at exposed panel edges.
 6. Curved-Edge Cornerbead: Use at curved openings.
- D. Exterior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners.
 2. LC-Bead: Use at exposed panel edges.
- E. Aluminum Trim: Install in locations indicated on Drawings.

3.05 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 2. Level 2: Panels that are tile substrate for ceramic or acoustical tile.

- 3. Level 3: Walls and Ceilings that will receive a thick splatter coat finish or heavy texture.
 - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "INTERIOR PAINTING."
- E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.06 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 4 - MEASUREMENT AND PAYMENT

- A. Gypsum Board as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 30 13

CERAMIC TILING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Porcelain tile.

1.02 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.
- E. Wet Wall Conditions: Walls receiving ceramic tile are considered wet wall exposure conditions if they are fixture mounted plumbing chase walls, walls within 2-feet of a water source such as shower, tub service sink or faucet. Wet wall conditions also include walls receiving ceramic tile that are exposed to external water due to spray, hosing or other means of water flushing from cleaning operations.
- F. Large Format Tile: The Ceramic Tile Council of North America (2012) Installation Guideline defines large format tile as a tile with any one dimension exceeding 15-inches.
- G. Installation of thin, flat tiles that are usually shaped with beveled edges. As a lining or covering a surface, may provide corrosion resistance, thermal protection, wear resistance, and/or surface decoration.

1.03 PERFORMANCE REQUIREMENTS

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
 - 1. Level Surfaces: Minimum 0.6.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.07 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
 - 1. Waterproof membrane.
 - 2. Crack isolation membrane.
 - 3. Metal edge strips.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:

2.02 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.03 TILE PRODUCTS

- A. For designations CT-1 through CT-x :
 - 1. Refer to the Finish Legend for details of each Basis of Design product selection
- B. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.
- D. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Waterproof membrane.
 - 2. Crack isolation membrane.
 - 3. Metal edge strips.
 - 4. Joint Sealants.
- E. Porcelain tile:
 - 1. Basis-of-Design Product: Refer to the Finish Legend and the Drawings. Subject to compliance with requirements, provide the product listed in the Finish Legend or comparable product approved by the Engineer from one of the following:
 - a. American Marazzi Tile, Inc.
 - b. American Olean; a division of Dal-Tile Corporation.
 - c. Ann Sacks
 - d. Atlas Concord Dragos Marble
 - e. Crossville, Inc.
 - f. Daltile.
 - g. Florida Tile, Inc.
 - h. Florim USA.
 - i. Grupo Porcelanite.
 - j. Highstyle Stone and Tile
 - k. Interceramic.
 - l. Iris US.
 - m. Nemo Tyle
 - n. Porcelanosa
 - o. Seneca Tiles, Inc.
 - p. Approved Equal.
 - 2. Face Size Variation: Rectified.
 - 3. Face: As indicated.
 - 4. Dynamic Coefficient of Friction: Not less than 0.42.
 - 5. Grout Color: As selected by the Engineer from manufacturer's full range.
 - 6. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile.

2.04 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Noble Company (The).
 - b. Approved Equal.

2.05 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARDEX Americas.
 - b. Boiardi Products Corporation; a QEP company.
 - c. Bonsal American, an Oldcastle company.
 - d. Bostik, Inc.
 - e. C-Cure.
 - f. Custom Building Products.
 - g. H.B. Fuller Construction Products Inc. / TEC.
 - h. Jamo Inc.
 - i. LATICRETE SUPERCAP, LLC.
 - j. MAPEI Corporation.
 - k. Merkrete; a Parex USA, Inc. brand.
 - l. Southern Grouts & Mortars, Inc.
 - m. Summitville Tiles, Inc.
 - n. Approved Equal.
 - 2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 3. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
 - 4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- B. Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARDEX Americas.
 - b. Bonsal American, an Oldcastle company.
 - c. Bostik, Inc.
 - d. C-Cure.
 - e. Custom Building Products.
 - f. H.B. Fuller Construction Products Inc. / TEC.
 - g. Jamo Inc.
 - h. LATICRETE SUPERCAP, LLC.
 - i. MAPEI Corporation.
 - j. Merkrete; a Parex USA, Inc. brand.

- k. Southern Grouts & Mortars, Inc.
 - l. Summitville Tiles, Inc.
 - m. Approved Equal.
 - 2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 3. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
- C. Organic Adhesive: ANSI A136.1, Type I.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARDEX Americas.
 - b. Bonsal American, an Oldcastle company.
 - c. Bostik, Inc.
 - d. C-Cure.
 - e. Custom Building Products.
 - f. H.B. Fuller Construction Products Inc. / TEC.
 - g. Jamo Inc.
 - h. LATICRETE SUPERCAP, LLC.
 - i. MAPEI Corporation.
 - j. Southern Grouts & Mortars, Inc.
 - k. Summitville Tiles, Inc.
 - l. Approved Equal.
 - 2. Adhesives shall have a VOC content of 65 g/L or less.

2.06 GROUT MATERIALS

- A. High-Performance Tile Grout: ANSI A118.7.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARDEX Americas.
 - b. Boiardi Products Corporation; a QEP company.
 - c. Bonsal American, an Oldcastle company.
 - d. Bostik, Inc.
 - e. C-Cure.
 - f. Custom Building Products.
 - g. H.B. Fuller Construction Products Inc. / TEC.
 - h. Jamo Inc.
 - i. LATICRETE SUPERCAP, LLC.
 - j. MAPEI Corporation.
 - k. Southern Grouts & Mortars, Inc.
 - l. Summitville Tiles, Inc.
 - m. Approved Equal.
 - 2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
 - 3. Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.

2.07 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Blanke Corporation.
 - b. Ceramic Tool Company, Inc.
 - c. Schluter Systems L.P.
 - d. Approved Equal.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.08 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates have properly cured as required by tile manufacturer or by waterproof membrane manufacturer, as applicable
 - 2. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 3. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

4. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 5. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with the Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Porcelain Tile: 1/4 inch.
- G. Metal Edge Strips: Install where exposed edge of tile flooring meets other flooring that finishes flush with or below top of tile and no threshold is indicated.

3.04 TILE BACKING PANEL INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.05 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.06 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches or larger.
 - c. Tiles installed with epoxy grout.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize

the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Porcelain Floor and Wall Tile: 1/4 inch.
- H. Grout tile to comply with requirements of the following tile installation standards:
1. For ceramic tile grouts (sand-Portland cement; dry-set, commercial Portland cement; and Latex-Portland cement grouts), comply with ANSI A108.10.
- I. Metal Edge Strips (Where Indicated): Angle, radius or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
1. Basis of Design Product: Schluter Systems L.P. transitions and reducers or a comparable approved product of one of the following:
 - a. Blanke Corporation.
 - b. Ceramic Tool Company, Inc.
 2. Tile to Concrete: Schluter-Schiene.
 3. Tile to Tile, Edge Termination or Transitions As Indicated: Schluter- Reno-U or Schluter-Reno-V.
 4. Tile Floor to Wall Transition (Coved): Schluter-Dilex-AHK with corner transitions, end caps and accessories.

3.07 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
1. Remove grout residue from tile as soon as possible.
 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
 3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
- C. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

- D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- E. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.08 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.09 INTERIOR FLOOR TILE INSTALLATION SCHEDULE

- A. Thin-set mortar on crack isolation membrane; TCNA F125-Partial or Full (over in-plane floor cracks).
 - a. Tile Type: As indicated in the Drawing Finish Legend.
 - b. Thin-Set Mortar: Latex- portland cement mortar.
 - c. Location: Use in conjunction with other concrete substrate installation methods where thin-set or medium set methods are required and crack isolation is required to treat existing in-plane cracks.

3.10 INTERIOR WALL TILE INSTALLATION SCHEDULE

- A. Tile Installation: Interior wall installation over backer board; thin-set mortar; W244C (wet conditions) with cementitious backer board and waterproof membrane; W243 (dry conditions) with Type X gypsum board; ANSI A108.5.
 - 1. Tile Type: As indicated in the Drawing Finish Legend.
 - 2. Thin-Set Mortar: Latex-Portland cement mortar.
 - 3. Medium Thin-Set Mortar for Large Format Tiles: Mortar indicated or manufacturer's recommended mortar.

PART 4 - MEASUREMENT AND PAYMENT

- A. Ceramic Tiling as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 51 23
ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles for interior ceilings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.
- B. Product test reports.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 50 or less.

2.02 ACOUSTICAL TILES

- A. Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work includes, but are not limited to the following: Armstrong, USG, CertainTeed.

- B. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264.
- C. Classification: Type IV, Pattern E.
- D. Color: White.
- E. Light Reflectance (LR): .86 or higher.
- F. Ceiling Attenuation Class (CAC): 40.
- G. Noise Reduction Coefficient (NRC): .80.
- H. Articulation Class (AC): 170.
- I. Edge/Joint Detail: Beveled tegular.
- J. Thickness: 3/4 inch.
- K. Modular Size: 24 inches by 24 inches.

2.03 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C635/C635M.
- B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Access: Downward and end pivoted or side pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, 24 by 24 inches.

2.04 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated in the Drawings. Comply with seismic design requirements.
- B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

2.05 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic

design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
- B. Layout openings for penetrations centered on the penetrating items.

3.02 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings according to ASTM C636/C636M , seismic design requirements, and manufacturer's written instructions.
- B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

3.03 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform inspections:
 - 1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

PART 4 - MEASUREMENT AND PAYMENT

- A. Acoustical Tile Ceilings as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 67 23
RESINOUS FLOORING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Resinous flooring.

1.02 DEFINITIONS

- A. Resinous Flooring: Resinous flooring is durable, seamless and attractive flooring that is typically applied on concrete substrate.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each resinous floor system required and for each color and texture specified.

1.04 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Flammability: Self-extinguishing in accordance with ASTM D635.

2.02 RESINOUS FLOORING

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated in system description in this Section, or on schedules in the Drawings or an approved comparable product by one of the following:
 - 1. Arizona Polymer Flooring, Inc.
 - 2. BASF Construction Chemicals, Inc.; BASF Building Systems.
 - 3. CornerStone Flooring & Linings.
 - 4. Crawford Laboratories Inc.; Flrock.
 - 5. Crossfield Products Corp.; Dex-O-Tex.
 - 6. Crown Polymers, LLC.
 - 7. Delta Polymers, Inc.
 - 8. DUDICK Inc.
 - 9. Dur-A-Flex, Inc.
 - 10. Garland Company, Inc. (The).
 - 11. General Polymers; Sherwin-Williams.
 - 12. HP Spartacoate, Inc.
 - 13. International Coatings Inc.
 - 14. Key Resin Company.
 - 15. Koster America
 - 16. NEOGARD; a division of Hempel
 - 17. Northern Industries, Inc.
 - 18. Nox-Crete Products Group.
 - 19. ITW Polymers Sealants North America (formerly Pacific Polymers, Inc.).
 - 20. Polymerica, Incorporated.
 - 21. PolySpec.
 - 22. Protective Floorings & Linings, Inc.; a division of Milamar Coatings, L.L.C.
 - 23. ROCK-TRED Corporation.
 - 24. Sauereisen.
 - 25. Sika Corporation U.S.
 - 26. Tennant.
 - 27. Tamms Industries, Inc.; a division of the Euclid Chemical Company.
 - 28. Tnemec Company, Inc.
 - 29. Tufco International. Inc.
 - 30. Approved Equal

2.03 URETHANE OVER EPOXY FLOORING

- A. Basis of Design Product: Neogard CG Series
- B. Materials:
 - 1. Crack and Joint Filler: 70718/70719 (25009/95048) flexible epoxy.
 - 2. Sealant: 70991 (47XJB) or other polyurethane sealant approved by Neogard.
 - 3. Fillers: 86468 (66040) silica flour, 86364 silica sand.
 - 4. Texture (Optional): 86500 (66XJB) Neogrip spheres.
 - 5. Primer / Base Coat: 70714/70715 (45060) clear epoxy.
 - a. Tensile Strength, ASTM D638, 3,700 psi
 - b. Elongation, ASTM D638, 25%
 - c. Compressive Strength, ASTM D695, 25,300 psi
 - d. Flexural Strength, ASTM D790, 3,180 psi

- e. Flexural Modulus, ASTM D790, 57,700 psi
- f. Water Resistance, ASTM D570, 0.21%
- g. MVT (10 mils), ASTM E96, 0.16
- h. Taber Abrasion, ASTM D4060, 25 mg (1,000 CS-17)
- i. Shore D, ASTM D2240, 78
- j. Adhesion, ASTM D4541, 350 psi
- 6. Base Coat: 70714/70715 (45060) pigmented epoxy.
- 7. Topcoat (70817 series, two options):
 - a. 70817/70818 (5707000050) clear or pigmented Chemical Resistant Urethane (CRU).
 - 1) Tensile Strength, ASTM D2370, 7,500 psi
 - 2) Elongation, ASTM D2370, 12%
 - 3) Shore D, ASTM D2240, 70
 - 4) Water Resistance, ASTM D471, < 1% (7 days)
 - 5) Taber Abrasion, ASTM D4060, 23 mg (1,000 CS-17)
 - 6) Anti-Microbial, JIS Z 2801-2010, Pass
 - b. 70817-01/70818 (5707016640) white CRU
 - 1) Tensile Strength, ASTM D2370, 5,800 psi
 - 2) 2. Elongation, ASTM D2370, 40%
 - 3) 3. Shore D, ASTM D2240, 65
 - 4) 4. Water Resistance, ASTM D471, < 1% (7 days)
 - 5) 5. Taber Abrasion, ASTM D4060, 17 mg (1,000 CS-17)
 - 6) 6. Anti-Microbial, JIS Z 2801-2010, Pass
- C. System Description: Chemically Resistant Urethane (CRU) over epoxy base.
 - 1. Surface Preparation: light shotblast on new concrete.
 - 2. CG-65:
 - a. Base: 70714/70715 epoxy+86364 sand aggregate, 100% solids, 20mil
 - b. Top coat: 70714/70715 epoxy, 100% solids, 10mil
 - c. CRU Coat: 70817/70818 clear or tinted CRU, 8mil
 - d. Optional Texture Coat: 70817/70818 CRU, 4mil
 - 1) Surface Texture: 86500 Neogrip Glass Sphere aggregate
 - 3. Color and Pattern: As scheduled in Finish Legend or match the Engineer's sample.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - 1. Roughen concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.

2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
 3. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. (304.8 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 4. Alkalinity and Adhesion Testing: Perform tests recommended in writing by resinous flooring manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer,
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.
1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

3.02 INSTALLATION

- A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.
- B. Primer: Apply primer over prepared substrate at spreading rate recommended in writing by manufacturer.
- C. Waterproofing Membrane: Apply waterproofing membrane where indicated on Drawings, in thickness recommended in writing by manufacturer.
 1. Apply waterproofing membrane to integral cove base substrates.
- D. Reinforcing Membrane: Apply reinforcing membrane to substrate cracks.
- E. Field-Formed Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring coats. Apply in accordance with manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
 1. Integral Cove Base: 4 inches (100 mm) high unless otherwise indicated on the Drawings.
- F. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness specified for flooring system.

1. Aggregates: Broadcast aggregates at rate recommended in writing by manufacturer. After resin is cured, remove excess aggregates to provide surface texture indicated.
- G. Troweled or Screeded Body Coats: Apply troweled or screeded body coats in thickness specified for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended in writing by manufacturer.
- H. Grout Coat: Apply grout coat to fill voids in surface of final body coat.
- I. Topcoats: Apply topcoats in number indicated for flooring system specified, at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.
- J. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

PART 4 - MEASUREMENT AND PAYMENT

- A. Resinous Flooring as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 91 13
EXTERIOR PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Concrete.
 - 2. Steel and iron.
 - 3. Galvanized metal.
 - 4. Aluminum (not anodized or otherwise coated).

1.02 REFERENCES

- A. NACE: Headquartered in Houston Texas, the National Association Of Corrosion Engineers International (NACE) was formed in 1943. In 2020, NACE and the Society for Protective Coatings (SSPC) announced a merger agreement.
- B. SSPC: Society for Protective Coatings (SSPC) is a professional association for the industrial and marine coatings, founded in 1950 as the Steel Structures Painting Council, a non-profit association.

1.03 DEFINITIONS

- A. MPI Gloss Level:
 - 1. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
 - 2. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
 - 3. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
 - 4. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
 - 5. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
 - 6. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.
- B. SSPC-SP1 – Solvent Cleaning
 - 1. Solvent Cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation. For complete instructions, refer to Society of Protective Coatings Surface Preparation Specification No.1.
- C. SSPC-SP2 – Hand Tool Cleaning
 - 1. Hand Tool Cleaning removes all loose mill scale, loose rust and other detrimental foreign matter. It is not intended that adherent mill scale, rust and paint be removed by this

process. Mill scale, rust, and paint are considered adherent if they cannot be removed by lifting with a dull putty knife. Before hand tool cleaning, remove visible oil, grease, soluble welding residues and salts by the methods outlined in SSPC-SP1. For complete instructions, refer to Society of Protective Coatings Surface Preparation Specification No.2.

D. SSPC-SP3 – Power Tool Cleaning

1. Power Tool Cleaning removes all loose mill scale, loose rust and other detrimental foreign matter. It is not intended that adherent mill scale, rust and paint be removed by this process. Mill scale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife. Before power tool cleaning, remove visible oil, grease, soluble welding residues and salts by the methods outlined in SSPC-SP1. For complete instructions, refer to Society of Protective Coatings Surface Preparation Specification No.3

E. SSPC-SP5/NACE 1 – White Metal Blast Cleaning

1. A White Metal Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods. For complete instructions, refer to Joint Surface Preparation Standard SSPC - SP5/NACE 1

F. SSPC-SP6/NACE 3 – Commercial Blast Cleaning

1. A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except for staining. Staining shall be limited to no more than 33% of each square inch of surface area and may consist of light shadows, slight streaks or minor discoloration caused by stains of rust, stains of mill scale or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods. For complete instructions, refer to Joint Surface Preparation Standard SSPC-SP6/NACE 3.

G. SSPC-SP7/NACE 4 – Brush-Off Blast Cleaning

1. A Brush-Off Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust and loose paint. Tightly adherent mill scale, rust and paint may remain on the surface. Mill scale, rust and coating are considered adherent if they cannot be removed by lifting with a dull putty knife after abrasive blast cleaning has been performed. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPCSP1 or other agreed upon methods. For complete instructions, refer to Joint Surface Preparation Standard SSPC-SP7/NACE 4

H. SSPC-SP10/NACE 2 – Near White Blast Cleaning

1. A Near-White Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks or minor discoloration caused by stains of rust, stains of mill scale or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods. For complete instructions, refer to Joint Surface Preparation Standard SSPC-SP10/NACE 2

- I. SSPC-SP11 – Power Tool Cleaning to Bare Metal
 - 1. Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. The profile shall not be less than 1 mil. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1, Solvent Cleaning, or other agreed upon methods. For complete instructions, refer to Society of Protective Coatings Surface Preparation Specification No.11
- J. SSPC-SP12/NACE 5 – High and Ultra-High Pressure Water Jetting for Steel and Other Hard Materials
 - 1. This standard provides requirements for the use of high and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only, without the addition of solid particles in the stream. For complete instructions, refer to Joint Surface Preparation Standard SSPC-SP12/NACE 5
- K. SSPC-SP13/NACE 6 – Concrete:
 - 1. This standard gives requirements for surface preparation of concrete by mechanical, chemical or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete and dust, and should provide a dry, sound, uniform substrate suitable for the application of protective coating or lining systems. (Depending upon the desired finish and system, a block filler may be required.) For complete instructions, refer to Joint Surface Preparation Standard SSPC-SP13/NACE 6.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include preparation requirements and application instructions.
 - 2. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 3. Indicate VOC content.
- B. Sustainable Design Submittals:
 - 1. Product Data: For paints and coatings, indicating VOC content.
- C. Samples for Initial Selection: For each type of topcoat product.
- D. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Label each coat of each Sample.
 - 3. Label each Sample for location and application area.
- E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.05 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. The Engineer will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: The Engineer will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by the Engineer at no added cost to the City.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Engineer specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.07 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carboline Company
 - 2. International Paint, Devoe Coatings; a brand of AkzoNobel.
 - 3. PPG Protective & Marine Coatings.
 - 4. Sherwin-Williams.
 - 5. Tnemec, Inc.
 - 6. Approved Equal.
- B. Products: Subject to compliance with requirements, provide one of the products listed in the Exterior Painting Schedule for the paint category indicated.

2.02 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. VOC Content: For field applications, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 100 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.
 - 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Shellacs, Clear: 730 g/L.
 - 9. Shellacs, Pigmented: 550 g/L.
- D. Colors: As indicated on FINISH LEGEND in the Drawings.

2.03 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: The City reserves the right to invoke the following procedure:
 - 1. The City will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. The City may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.

2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and CMUs): 12 percent.
 4. Wood: 15 percent.
 5. Portland Cement Plaster: 12 percent.
 6. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
1. SSPC-SP 2.
 2. SSPC-SP 3.
 3. SSPC-SP 7/NACE No. 4.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.03 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: The City may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 EXTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
 - 1. 2 coats Zero VOC acrylic semigloss, over high performance acrylic concrete/masonry primer.
 - a. PPG Protective & Marine Coatings.
 - 1) Primer: Perma-Crete High-Performance Acrylic Concrete/Masonry Primer, 4-2 series (4.0 mils wet, 1.4 mils dry)
 - 2) Two Topcoats: Speedhide Low VOC (50g/L) Exterior Semi-Gloss Acrylic, 6-900XI series (MPI#11) (4.0 wet, 1.4 dry per coat)
 - b. Sherwin-Williams.
 - 1) Primer: Loxon Concrete & Masonry Primer Sealer, LX02W50, (8.0 mils wet, 3.2 mils dry)
 - 2) Two Topcoats: A-100 Exterior Latex Satin, A82 Series, (4.0 mils wet, 1.5 mils dry, per coat)
- B. Concrete Substrates, Horizontal Surfaces:
 - 1. Hazard and Safety Striping: Epoxy Non-Slip Deck Coating System.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Epoxy deck coating (slip resistant).
 - 1) American Safety Technologies; an ITW Polymers Coatings North America brand; AS-150 HAPS Free.
 - 2) PPG Industries, Inc.; MegaSeal NSP.
 - 3) Tnemec
 - d. Color: As indicated on Drawings.
 - e. Width: As indicated on Drawings.
- C. Miscellaneous Steel Substrates:
 - 1. Rust-inhibitive acrylic universal primer, and 2 coats Zero VOC acrylic semigloss.
 - a. PPG Protective & Marine Coatings.
 - 1) Primer: Pitt-Tech Plus Rust-Inhibitive, Acrylic, Universal Primer, 90-912 series (MPI#107)(5.1 – 10.2 wet, 2.0 – 4.0 dry per coat).
 - 2) Two Topcoats: Pitt-Tech Plus Acrylic DTM Industrial Enamel, 90-1210XI (90g/L) semigloss series (MPI#153 & #163)(5.0 – 9.0 Wet, 2.0 – 4.0 dry per coat))
 - b. Sherwin-Williams.
 - 1) Primer: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, (5.0 to 10 mils wet, 2.0 to 4.0 mils dry)
 - 2) Two Topcoats: Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series, (2.5 to 4.0 mils dry, per coat)
- D. Shop-Primed Steel Railings:
 - 1. Waterbased/Alkyd Urethane System: over shop coat primer.
 - a. PPG Protective & Marine Coatings.

- b. Sherwin-William.
 - 1) Primer: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, (5.0 to 10 mils wet, 2.0 to 4.0 mils dry)
 - 2) Two Topcoats: Pro Industrial WaterBased Alkyd Urethane Semi-Gloss B53-1150Series, (1.4 mils dry, per coat)
- E. Shop-Primed Structural Steel Substrates:
 - 1. High build polyamide epoxy intermediate coat with 1 coat semigloss high-build acrylic polyurethane finish.
 - a. PPG Protective & Marine Coatings.
 - 1) Primer: Amercoat 385 High-Build Epoxy Primer (4.0 – 6.0 mils DFT)
 - 2) One Topcoat: Amershield High-Build Polyurethane (Gloss)(3.0 – 5.0 mils DFT).
 - b. Sherwin-William.
 - 1) Primer: Macropoxy 646-100 Epoxy, B58-600 Series, (5.0-10.0 mils dry)
 - 2) One Topcoat: Sher-Loxane 800 Polysiloxane, B80 Series, (4.0-6.0 mils dry)
- F. Galvanized-Metal Substrates, Except Railings:
 - 1. High solids, high build, polyamide epoxy prime coat, with high performance acrylic semigloss.
 - a. Carboline Company
 - 1) Primer: Carboguard 888.
 - 2) Topcoats: 2 coats, Carbocrylic 3359.
 - b. International Paint, Devoe Coatings; a brand of AkzoNobel.
 - 1) Primer: Devran 201H.
 - 2) Topcoats: 2 coats, Devcryl 1449.
 - c. PPG Protective & Marine Coatings.
 - 1) Primer: Amercoat 385 High-Build Epoxy Primer (4.0 – 6.0 mils DFT).
 - 2) Two topcoats, Pitt-Tech Plus Int./Ext. Semi-Gloss DTM Industrial Enamel, 90-1210XI series (90g/L) semigloss series (MPI#153 & #163)(5.0 – 9.0 Wet, 2.0 – 4.0 dry per coat).
 - d. Sherwin-Williams.
 - 1) Primer: Macropoxy 646-100 Epoxy, B58-600 Series, (5.0-10.0 mils dry).
 - 2) Topcoats: 2 coats, Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series, (2.5 to 4.0 mils dry, per coat)
 - e. Tnemec, Inc.
 - 1) Primer: Series 135 Chembuild.
 - 2) Topcoats: 2 coats, Series 1029 Enduratone.
- G. Galvanized-Metal Railings:
 - 1. High solids, high build, polyamide epoxy prime coat, with semigloss aliphatic acrylic polyurethane finish coat.
 - a. Carboline Company
 - 1) Primer: Carboguard 888.
 - 2) Topcoats: 2 coats, Carbothane 133LH.
 - b. International Paint, Devoe Coatings; a brand of AkzoNobel.
 - 1) Primer: Devran 201H.
 - 2) Topcoats: 2 coats, Devthane 378.
 - c. PPG Protective & Marine Coatings.
 - 1) Primer: Amercoat 385.
 - 2) Two Topcoats: 2 coats, Amershield High-Build Polyurethane (Gloss)(3.0 – 5.0 mils DFT per coat).

- Two Topcoats: Two-Component, Polysiloxane-Engineered UV-Stable Epoxy, PSX700 series (Gloss) (3.0 – 7.0 mils DFT per coat)
- d. Sherwin-Williams.
 - 1) Primer: Macropoxy 646-100 Epoxy, B58-600 Series, (5.0-10.0 mils dry).
 - 2) Topcoats: 2 coats, Hi-Solids Polyurethane, B65-350 Series B60V30 (3.0-5.0 mils dft).
 - e. Tnemec, Inc.
 - 1) Primer: Series 135 Chembuild.
 - 2) Topcoats: 2 coats, Series 1075 Endurashield II.
- H. Aluminum Substrates:
- 1. Acrylic universal primer, and 2 coats Zero VOC acrylic semigloss.
 - a. Carboline Company
 - b. International Paint, Devoe Coatings; a brand of AkzoNobel.
 - c. PPG Protective & Marine Coatings.
 - 1) Primer: Pitt-Tech Plus Rust-Inhibitive, Acrylic, Universal Primer, 90-912 series (MPI#107)(5.1 – 10.2 wet, 2.0 – 4.0 dry per coat).
 - 2) Two Topcoats:: Pitt-Tech Plus Acrylic DTM Industrial Enamel, 90-1210XI (90g/L) Semi-Gloss series (MPI#153 & #163)(5.0 – 9.0 Wet, 2.0 – 4.0 dry per coat)
 - d. Sherwin-Williams.
 - 1) Primer: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, (5.0 to 10 mils wet, 2.0 to 4.0 mils dry)
 - 2) Two Topcoats: Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series, (2.5 to 4.0 mils dry, per coat)

PART 4 - MEASUREMENT AND PAYMENT

- A. Exterior Painting as specified herein shall be included in the measurement and payment for "Thermal and Moisture Protection".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.
 - 1. Concrete.
 - 2. Concrete masonry units (CMU).
 - 3. Steel.
 - 4. Galvanized metal.
 - 5. Wood.
 - 6. Gypsum board.
 - 7. Cotton or canvas insulation covering.
 - 8. Shower and hydrotherapy room ceilings.
 - 9. Concrete floor coating.

1.02 REFERENCES

- A. NACE: Headquartered in Houston Texas, the National Association Of Corrosion Engineers International (NACE) was formed in 1943. In 2020, NACE and the Society for Protective Coatings (SSPC) announced a merger agreement.
- B. SSPC: Society for Protective Coatings (SSPC) is a professional association for the industrial and marine coatings, founded in 1950 as the Steel Structures Painting Council, a non-profit association.

1.03 DEFINITIONS

- A. Gloss Level 1 (Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5 (Semigloss): 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D 523.

- H. Areas Subject to Moisture and Food Preparation: Spaces that have permanent plumbing connections and appliances. These include, but are not limited to, toilet rooms, janitor's closets, locker rooms, shower rooms, training rooms, first aid rooms, concession stands, commissaries, kitchens, and laundries.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Label each coat of each Sample.
 - 3. Label each Sample for location and application area.
- D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.05 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. The Engineer will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Shower and hydrotherapy room ceilings.
 - c. Other Items: The Engineer will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by the Engineer at no added cost to the City.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Engineer specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.07 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated in INTERIOR PAINTING SCHEDULE at the end of PART 3, or comparable product by one of the following.
 - 1. Benjamin Moore & Co.
 - 2. Glidden Professional.
 - 3. PPG Architectural Finishes, Inc.
 - 4. Sherwin-Williams Company (The).
 - 5. Approved Equal.
- B. Colors: As indicated in FINISH LEGEND on Drawings.

2.02 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 100 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.
 - 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Floor Coatings: 100 g/L.
 - 9. Shellacs, Clear: 730 g/L.
 - 10. Shellacs, Pigmented: 550 g/L.
- C. Colors: As indicated in a color schedule on the Drawings.
 - 1. Thirty percent of surface area will be painted with deep tones.

2.03 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: The City reserves the right to invoke the following procedure:
 - 1. The City will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. The City may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: 12 percent when measured with an electronic moisture meter, unless otherwise indicated:
 - 1. Wood: 15 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove oil, grease, dust, dirt, rust, and loose mill scale. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. Shop Priming Preparation: SSPC-SP 7/NACE No. 4.
 - 2. Field Priming Preparation: SSPC-SP 11.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.03 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint exposed surfaces, except where the Finish Schedule indicates that a surface or material is not to be painted or is to remain natural. If the schedule does not indicate color or finish, match adjacent materials or surfaces.
 - 3. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 4. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by the Engineer.
 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: The City may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
 - 1. PreCatalized Epoxy; Areas Subject to High Abrasion: 2 coats eggshell, PreCatalyzed epoxy.
 - a. Benjamin Moore:
 - 1) 1st Coat: Benjamin Moore SuperSpec Interior/Exterior Acrylic High Build Masonry Primer N068 (97g/L), MPI # 3, LEED 2009.
 - 2) 2nd Coat: Benjamin Moore Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.
 - 3) 3rd Coat: Benjamin Moore Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L), LEED 2009.
 - b. PPG
 - 1) 2 coats: PITT Glaze Interior Eggshel Pre-Catalyzed Water-Borne Acrylic Epoxy, 16-510.
 - c. Sherwin Williams:
 - 1) 2 Coats SW Pro Industrial Pre-Catalyzed Waterbased Epoxy EgShel, K45-1151 Series, at 1.5 mils dry, per coat. (LEEDv4)(CHPS)
- B. Concrete Substrates, Traffic Surfaces:
 - 1. Clear: Water-based epoxy floor coating, low-VOC, with aggregate for non-skid finish.
 - a. Benjamin Moore.
 - 1) 2 Coats Corotech Aliphatic Urethane Coating V515 (447 g/L)
 - b. PPG
 - 1) PPG Amercoat's Low VOC, Water-Clear, Polysiloxane-Engineered Epoxy, PSX700A series. (3.0 mils DFT per coat).
 - 2) 220 Mesh Aluminum Oxide Aggregate.
 - c. Sherwin Williams
 - 1) SW General Polymers 4408 WB Polyurethane, Gloss, GP4408/GP4408B01 (4 to 6 mils wet)
 - 2) SW General Polymers 5240 220 Mesh Aluminum Oxide, GP5240C01.
 - 2. Opaque: High solids, heavy duty, 2-component, catalyzed, polyamide epoxy:
 - a. Benjamin Moore.
 - 1) 2 Coats Corotech 100% Solids Epoxy Floor Coating V430 (13 g/L).
 - b. PPG
 - 1) 1st coat: MegaSeal HSPC, 100% Volume Solids, High-Build, Epoxy Primer (6.0 – 10.0 mils DFT)

- 2) 2 coats: Two-Component, High-Solids, High-Build, Polysiloxane-Engineered, UV-Stable Epoxy, PSX700 series (3.0 – 7.0 mils DFT per coat)(84g/L).
 - c. Sherwin Williams
 - 1) 2 coats SW Armorseal 8100 Water Based Epoxy Floor Coating, B70 Series, (2.0 to 4.0 mils dry, per coat). (LEEDv4)(CHPS)
- C. CMU Substrates, for Unfilled Finish:
- 1. Latex: 2 coats zero VOC latex eggshell, over high performance acrylic concrete/masonry primer.
 - a. Benjamin Moore.
 - 1) 1 Coat Benjamin Moore Ultra Spec Masonry Int/Ext 100% Solids Acrylic Sealer Primer 608 (46 g/L).
 - 2) 2 Coats Benjamin Moore Ultra Spec 500 Eggshell N538 (0 g/L).
 - b. PPG
 - 1) PPG Paints: 1st coat: Perma-Crete Concrete/Masonry Primer, 4-2 series (6.4 – 8.0 wet, 2.6 – 3.2 dry).
 - 2) 2 coats: Speedhide Zero VOC Latex Eggshell, 6-4310XI series (4.0 wet, 1.5 dry per coat) (MPI#44,44 X-Green,144,144 X-Green) (LEEDv4)(CHPS).
 - c. Sherwin Williams:
 - 1) 1 Coat SW Loxon Concrete & Masonry Primer, LX02W50Series (5.3 to 8 mils wet, 2.1 to 3.2 mils dry) (LEEDv4)(CHPS)
 - 2) 2 Coats SW ProMar 200 Zero VOC Latex Eg-Shel, B20-12600 Series (4 mils wet, 1.6 mils dry per coat). (LEEDv4)(CHPS)
- D. CMU Substrates, with Block Filler:
- 1. Latex: 2 coats zero VOC latex eggshell, over latex block filler.
 - a. Benjamin Moore.
 - 1) 1st Coat: Benjamin Moore Ultra Spec Hi-Build Masonry Block Filler Flat 571 (45 g/L).
 - 2) 2nd Coat: Benjamin Moore Ultra Spec 500 Eggshell N538 (0 g/L).
 - 3) 3rd Coat: Benjamin Moore Ultra Spec 500 Eggshell N538 (0 g/L).
 - b. PPG
 - 1) 1st coat: Speedhide Interior/Exterior Latex Block Filler, 6-15 series (16.0 wet, 7.0 dry)(MPI#4).
 - 2) 2 coats: Speedhide Zero VOC Latex Eggshell, 6-4310XI series (4.0 wet, 1.5 dry per coat)(MPI#44,44 X-Green,144,144 X-Green)(LEEDv4)(CHPS).
 - c. Sherwin Williams:
 - 1) 1 Coat SW PrepRite Interior/Exterior Latex Block Filler, B25W25 (16 mils wet, 8 mils dry) (LEEDv4)(CHPS)
 - 2) 2 Coats SW ProMar 200 Zero VOC Latex Eg-Shel, B20-12600 Series (4 mils wet, 1.6 mils dry per coat). (LEEDv4)(CHPS)
 - 2. Epoxy, Unless Otherwise Indicated: 2 coats water-based catalyzed semigloss epoxy, over latex block filler. Subject to High Abrasion, Hallways or Stairwells or Toilet Rooms or Locker Rooms or Food Preparation: 2 coats Semi-gloss, PreCatalyzed epoxy.
 - a. Benjamin Moore.
 - 1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L),
 - 2) 2nd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L),
 - 3) 3rd Coat: Corotech Pre-Catalyzed Waterborne Epoxy Semi-Gloss V341 (71 g/L),
 - b. PPG

- 1) 1st coat: Perma-Crete Concrete/Masonry Primer 4-2 series (6.4 – 8.0 wet, 2.6 – 3.2 dry).
- 2) 2 coats: Pitt-Glaze Pre-Catalyzed WB Epoxy, 16-510 Semi-Gloss series. (4.0 wet, 1.5 dry per coat)(MPI#153).
- c. Sherwin Williams:
 - 1) 1 Coat SW PrepRite Interior/Exterior Latex Block Filler, B25W25 (16 mils wet, 8 mils dry) (LEEDv4)(CHPS)
 - 2) 2 Coats SW Pro Industrial Pre-Catalyzed Water-based Epoxy Semi-Gloss, K46-1150 Series (4 mils wet, 1.5 mils dry per coat) (LEEDv4)(CHPS).
3. Epoxy in Areas Subject to Moisture or Shower Walls: 2 coats semigloss, high solids, high build, fast drying, polyamide epoxy, over high solids epoxy filler/sealer.
 - a. Benjamin Moore.
 - 1) 1st Coat: Corotech Acrylic Block Filler V114 (43 g/L),
 - 2) 2nd Coat: Corotech Fast Dry Polyamide Epoxy V410 (241 g/L).
 - 3) 3rd Coat: Corotech Fast Dry Polyamide Epoxy V410 (241 g/L).
 - b. PPG
 - 1) 1st coat: Amerlock 400BF High-Solids Epoxy Block Filler/Sealer (10.0 – 20.0 mils DFT)
 - 2) 2 coats: Amerlock 2/400 High-Solids, Fast-Cure, Epoxy Semi-Gloss (4.0 – 8.0 mils DFT per coat)(MPI#108).
 - c. Sherwin Williams:
 - 1) 1 Coat Kem Cati-Coat HS Epoxy Filler/Sealer, B42W400/B42V401 (14 to 28 mils wet, 10 to 20 mils dry)
 - 2) 2 Coats Macropoxy 646-100 Fast Cure Epoxy, Semi-Gloss, B58-620/B58V620 (7 to 13.5 mils wet, 5 to 10 mils dry per coat).
- E. Steel, Aluminum, Galvanized Substrates:
 1. Rust-inhibitive acrylic universal primer, and 2 coats zero VOC acrylic, semigloss.
 - a. Benjamin Moore.
 - 1)
 - b. PPG Paints:
 - 1) 1st coat: Pitt-Tech Plus Rust-Inhibitive Acrylic Universal Primer, 90-912 series (5.1 – 10.2 wet, 2.0 – 4.0 dry)(MPI#107).
 - 2) 2 coats: Pitt-Tech Plus Acrylic DTM Enamel, 90-1210XI Semi-Gloss series (5.0 – 9.0 wet, 2.0 – 4.0 dry per coat)(MPI#153 & 163).
 - c. Sherwin Williams:
 - 1) 1 Coat Pro Industrial Pro-Cryl Universal Water Based Primer, B66-310 Series (5 to 10 mils wet, 2 to 4 mils dry). (LEEDv4)(CHPS)
 - 2) 2 Coats Pro Industrial Zero VOC Acrylic, Semi-Gloss, B66-650 Series (6 to 12 mils wet, 2.5 to 4 mils dry per coat). (LEEDv4)(CHPS)
 - d. TNE MEC
 - 1) System Type: Polyamidoamine Epoxy/Waterborne Urethane.
 - 2) Surface Preparation: ASTM D 6386 Abrasive Blast or Zinc Phosphate Treatment for Galvanized Steel.
 - 3) Primer: Must be applied within one hour after surface preparation. Tnemec; Series 66HS Hi-Build Epoxoline, DFT 3.0 to 5.0 mils (75 to 125 microns).
 - 4) Finish Coat: Tnemec; Series 740 UVX or Tnemec; Series 1080 Endura-Shield (gloss), DFT 2.0 to 3.0 mils (50 to 75 microns).
 - 5) Tnemec; Series 750 UVX or Tnemec; Series 1081 Endura-Shield (semi-gloss), DFT 2.0 to 3.0 mils (50 to 75 microns).
 - 6) Total DFT: 5.0 to 8.0 mils (125 to 205 microns).

- F. Shop-Primed Metal Surfaces, Excluding handrails, Including Hollow Metal Doors, Frames, and Other Miscellaneous Primed Steel Surfaces:
1. 2 coats zero VOC acrylic, semigloss.
 - a. Benjamin Moore.
 - 1) Shop Acrylic Metal Primer.
 - 2) 2nd Coat: Benjamin Moore Ultra Spec 500 Semi-Gloss 539 (0 g/L).
 - 3) 3rd Coat: Benjamin Moore Ultra Spec 500 Semi-Gloss 539 (0 g/L).
 - b. PPG Paints:
 - 1) Shop Acrylic Metal Primer.
 - 2) 2 coats: Pitt-Tech Plus Acrylic DTM Enamel, 90-1210XI Semi-Gloss series (5.0 – 9.0 wet, 2.0 – 4.0 dry per coat)(MPI#153 & 163).
 - c. Sherwin Williams
 - 1) 2 Coats Pro Industrial Zero VOC Acrylic, Semi-Gloss, B66-650 Series (6 to 12 mils wet, 2.5 to 4 mils dry per coat). (LEEDv4)(CHPS)
- G. Steel Substrates, (Existing Exposed Structural Steel)
1. Location: Pool or High Humidity areas.
 2. Acrylic Urethane, Gloss
 - a. Benjamin Moore.
 - b. PPG
 - 1) Spot Prime: Apply to metal where rust has been removed Penetrating epoxy pre-primer, 1.5 - 2.0 mils DFT.
 - 2) Prime Coat: High-performance polyamide epoxy coating, 3.0 - 6.0 mils DFT.
 - 3) Intermediate Coat: Acrylic urethane coating, 2.0 - 4.0 mils DFT.
 - 4) Topcoat: Acrylic urethane coating, 2.0 - 4.0 mils DFT.
 - c. Sherwin Williams
 - 1) Spot Prime: Apply to metal where rust has been removed MacroPoxy 5000 pre-primer, 1.5 - 2.0 mils DFT.
 - 2) Prime Coat: Macropoxy 646-100 Fast Cure Epoxy, Semi-Gloss, B58-620/B58V620 (7 to 13.5 mils wet, 5 to 10 mils dry per coat).
 - 3) Intermediate Coat: Hi-Solids Polyurethane 250, B65 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.
 - 4) Topcoat: Hi-Solids Polyurethane 250, B65 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.
- H. Wood Substrates; Opaque Finish: 2 coats zero VOC acrylic over premium wood latex primer, semigloss.
- a. Benjamin Moore.
 - 1) 1st Coat: Benjamin Moore Fresh Start Multi-Purpose Primer N023 (44 g/L).
 - 2) 2nd Coat: Benjamin Moore Ultra Spec 500 Semi-Gloss 539 (0 g/L).
 - 3) 3rd Coat: Benjamin Moore Ultra Spec 500 Semi-Gloss 539 (0 g/L)
 - b. PPG
 - 1) 1st coat: Seal-Grip Interior Latex Wood Primer, 17-921 series (4.0 wet, 1.6 dry) (MPI#6,17,39, & 107
 - 2) 2 coats: Pitt-Tech Plus Acrylic DTM Enamel, 90-1210XI Semi-Gloss series (5.0 – 9.0 wet, 2.0 – 4.0 dry per coat).
 - c. Sherwin Williams
 - 1) 1 Coat SW Multi-Purpose Latex Primer, B51-450 Series (4 mils wet, 1.44 mils dry). (LEEDv4)(CHPS)
 - 2) 2 Coats SW Pro Industrial Zero VOC Acrylic, Semi-Gloss, B66-650 Series (6 to 12 mils wet, 2.5 to 4 mils dry per coat). (LEEDv4)(CHPS)

PART 4 - MEASUREMENT AND PAYMENT

- A. Interior Painting as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Washroom accessories.
 - 2. Warm-air dryers.
 - 3. Custodial accessories.
 - 4. Under Lavatory Guards

1.02 DEFINITIONS

- A. Toilet accessories: Fixtures for dispensing and storing product used in, and facilitating the use of restrooms, locker rooms and janitors closets.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Include electrical characteristics.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify products using designations indicated.

1.04 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.07 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.08 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
 - 1. When Basis of Design product is listed below, provide comparable quality and aesthetically consistent product from the available manufacturers listed below.
- B. Washrooms and Custodial Accessory Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. Brey-Krause Manufacturing Co.
 - f. GAMCO Specialty Accessories; a division of Bobrick.
 - g. Seachrome Corporation.
 - h. Tubular Specialties Manufacturing, Inc.
 - i. Sloan Valve Company
 - j. Approved Equal
- C. Warm-Air Dryer Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. AJW Architectural Products.
 - b. American Dryer, Inc.
 - c. American Specialties, Inc.
 - d. Bobrick Washroom Equipment, Inc.
 - e. Bradley Corporation.
 - f. Dyson Inc.
 - g. Excel Dryer Inc.
 - h. GAMCO Specialty Accessories; a division of Bobrick.
 - i. Saniflow Hand Dryer Corporation.
 - j. Sloan Valve Company.
 - k. Tubular Specialties Manufacturing, Inc.
 - l. World Dryer Corporation.
 - m. Approved Equal
- D. Under Lavatory Guard Manufacturers: Subject to compliance with requirements, provide products by one of the following

- a. Plumberex Specialty Products, Inc.
- b. Truebro by IPS Corporation.
- c. Approved Equal

2.02 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 PUBLIC-USE WASHROOM ACCESSORIES

- A. Liquid-Soap Dispenser surface mount:
 - 1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-2111 ClassicSeries.
 - 2. Description: Designed for dispensing soap in liquid or lotion form.
 - 3. Mounting: Vertically oriented, surface wall mounted.
 - 4. Capacity: 40 oz.
 - 5. Material and Finish: Stainless steel, No. 4 finish (satin).
 - 6. Lockset: Hinged lid with special key.
 - 7. Refill Indicator: Window type.
- B. Paper Towel (Folded) Dispenser:
 - 1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-262 ClassicSeries.
 - 2. Mounting: Surface mounted.
 - 3. Minimum Capacity: 400 C-fold or 525 multifold towels.
 - 4. Material and Finish: Stainless steel, No. 4 finish (satin).
 - 5. Lockset: Tumbler type.
 - 6. Refill Indicators: Pierced slots at sides.
- C. Toilet Tissue (Roll) Dispenser:
 - 1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-2888 ClassicSeries.
 - 2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
 - 3. Mounting: Surface mounted.
 - 4. Operation: Noncontrol delivery
 - 5. Capacity: 2 tissue rolls, 4-1/2 to 5 inch diameter.
 - 6. Material and Finish: ABS plastic, Grey.
- D. Mirror Unit:
 - 1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-290 Series.
 - 2. Frame: Stainless-steel angle, 0.05 inch thick, beveled inside edge.
 - a. Corners: Welded and ground smooth.
 - 3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. Manufacturer's screw locking design wall bracket.
 - 4. Size: 18 by 36 inches, unless otherwise indicated.
- E. Grab Bars:
 - 1. 10 33: 36 inch Toilet rear wall
 - 2. 10 34: 42 inch Toilet side wall.
 - 3. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-6806 Series.
 - 4. Mounting: Flanges with concealed fasteners.
 - 5. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth or peened, No. 4 finish (satin).
 - 6. Outside Diameter: 1-1/2 inches.
 - 7. Configuration and Length: As indicated on Drawings.
- F. Underlavatory Guard:
 - 1. Basis-of-Design Product: Truebro Inc.; Handi Lav-guard

2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
 3. Material and Finish: Antimicrobial, molded plastic, white.
- G. Mop and Broom Holder:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-223 x 36
 2. Length: 36 inches.
 3. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
 4. Material and Finish: Stainless steel, No. 4 finish (satin).

2.04 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- D. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- E. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- F. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- G. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.05 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to the City's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.02 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

PART 4 - MEASUREMENT AND PAYMENT

- A. Toilet and Bath Accessories as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 DEFINITIONS

- A. Fire Extinguisher: A portable device that discharges a jet of water, foam, gas, or other material to extinguish a fire.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.05 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amerex Corporation.
 - b. Ansul; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Babcock-Davis.
 - d. Badger Fire Protection; a Carrier company.
 - e. Buckeye Fire Equipment Company.
 - f. Fire-End & Croker Corporation.
 - g. Guardian Fire Equipment, Inc.
 - h. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
 - i. Kidde; Carrier Global Corporation.
 - j. Larsen's Manufacturing Company.
 - k. MOON American, Inc.
 - l. Nystrom, Inc.
 - m. Potter Roemer LLC; a Division of Morris Group International.
 - n. Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America.
 - o. Strike First Corporation of America.
 - p. Approved Equal.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type: UL-rated 10 lb. 4-A:80-B-C nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.03 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
- B. Identification: Triangular wall mounted signs. Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by the Engineer.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
 - 1. Mounting Height: Top of fire extinguisher to be at 42 inches (1067 mm) above finished floor.

PART 4 - MEASUREMENT AND PAYMENT

- A. Fire Extinguishers as specified herein shall be included in the measurement and payment for "Interior Build-Out".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 10 56 30
INDUSTRIAL STORAGE RACKS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes Industrial Storage Racks:
 - 1. Pallet rack, front loading.

1.02 DEFINITIONS

- A. Pallet Rack: A steel structure of two or more upright frames, beams and connectors to allow the vertical storage of palletized materials placed by forklift.

1.03 SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - 2. Loading and Bracing calculations
 - 3. Accessories
- B. Installation instructions

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. For the purposes of this specification the rack category, "medium weight," "heavy weight," will be as follows. Load is given per shelf in pounds for evenly distributed load. This does not limit the shelf size, only the shelving category. Loading per rack evenly distributed:
 - 1. Heavy Duty Rack 36 inch deep by 8ft: 600 Lb/LinFt
- B. Seismic Braced Installations:
 - 1. Submit detail drawings of bracing along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed.
 - a. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction.

- b. Provide calculations and drawings that are stamped by a registered structural engineer, and that verify the capability of structural members to which bracing is attached for carrying the load from the brace.
- c. Design must be based on actual equipment and system layout. Design must include calculated dead loads, static seismic loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.
- d. Include drawing for Mission Critical Equipment and Designated Seismic System Equipment indicating the equipment location in the facility sufficient to be used for the installation. Roof or wall braced racks must have support members designed and anchored to building structural steel or concrete as required for seismic restraint and wind loads.

2.02 RIGID BASE MOUNTED AND OVERHEAD BRACED RACKS

- A. Equipment furnished under this contract must be rigidly mounted using cast-in-place anchor bolts to anchor them or post-installed anchors that are qualified for earthquake loading in accordance with ACI 355.2 and ACI 355.4.
 - 1. Anchor bolts must conform to ASTM F1554-07ae1. For any rigid equipment which is rigidly anchored, provide flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.
 - 2. Mission critical base mounted and suspended equipment for Risk Category (RC) V, and Designated Seismic Systems (DSS) RC IV buildings assigned to Seismic Design Category Coefficient (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each anchor bolt.
- B. Provide storage rack units indicated. Provide storage rack units designed for full dead and live load, designated medium duty. Provide floor and wall anchorages for units in Seismic Zone 3 or 4.
- C. Manufactured Units
 - 1. Provide storage rack units indicated. Provide storage rack units designed for full dead and live load, designated medium duty. Provide floor and wall anchorages for units in Seismic Zone 3 or 4.
- D. Pallet Rack Frames
 - 1. Pallet Rack Upright Frames to be furnished completely fabricated, welded into rigid units. Standard finish baked powdercoat enamel. Securely anchor to the floor and overhead brace as required to meet seismic requirements.
- E. Pallet Rack Beams
 - 1. Roll-formed one piece beams to achieve high strength-to-weight ratio with formed step for accessory use. Beam end connectors fully welded and stamped with the load bearing capacity. Beams finished in baked enamel high visibility color.
- F. Accessories
 - 1. Steel Wire Mesh Decking: Approximately 2-1/2 by 4-inch wire openings with a baked enamel finish and heavy gauge steel channel supports.
 - 2. Heavy Duty Cross Bars as required for load.

2.03 FINISH

- A. Provide the Storage Rack units in the manufacturer's standard colors as indicated. Clean metal by multiple stage phosphatizing and sealing process, for rust resistance and paint adhesion. Provide electrostatically applied enamel finish coats, baked hard for a minimum of 30 minutes at 149 degrees C 300 degrees F.

2.04 SOURCE QUALITY CONTROL

- A. MHI MH16.1, For tests of shelf capacity, lateral stability and shelf connections.
- B. Impact resistant finish, ASTM D2794, no loss of adhesion after direct and reverse impact equal to 1.5 times metal thickness in mm, expressed in N.m inch pounds.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before installation, examine shelving units for dents and scratches. Replace damaged shelving.

3.02 INSTALLATION

- A. Install Storage Rack according to manufacturer's installation instructions. Make wall and floor connections as indicated.

3.03 PROTECTION

- A. Cover and protect Storage Rack from damage during the completion of construction. Remove prior to acceptance of project.

PART 4 - MEASUREMENT AND PAYMENT

- A. Industrial Storage Racks as specified herein shall be included in the measurement and payment for "Equipment".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 11 11 05
SHOP SERVICE EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Removal of existing pressure washer
 - 2. Supply and install new Pressure Washer.
 - 3. Relocation of Air Compressor
 - 4. Test Benches (CFCI)

1.02 DEFINITIONS

- A. Pressure Washer: a high-pressure mechanical sprayer used to remove loose paint, mold, grime, dust, mud, and dirt from surfaces and objects such as buildings, vehicles, and concrete surfaces.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site.

1.04 ACTION SUBMITTALS

- A. Early submittal items:
 - 1. Workbench
- B. Product Data: For each type of product.
- C. Shop Drawings: For stationary loading dock equipment.
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of anchors and each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.08 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace dock levelers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Structural Assembly: 10 years from date of Substantial Completion.
 - 2. Warranty Period for Hydraulic and Electrical Systems: Four years from date of Substantial Completion.
 - 3. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.01 TEST BENCHES

- A. Contractor furnished and Contractor installed.
- B. Basis of Design: JM Test Systems, LLC: Quote # TBE-22-2512-04 dated 12/22/2023.
 - 1. 1-800-353-3411, www.jmtest.com/test-bench, www.jmtest.com.
 - 2. See attached information at the end of this Section.

2.02 AIR COMPRESSOR

- A. Relocate existing unit as indicated on Drawings.

2.03 PRESSURE WASHERS

- A. Stationary Self-Contained Pressure Washing Unit. High pressure, hot water.
 - 1. Basis of performance product: HOTSYS model 5735SS (Stationary). Submit product of equal or better performance and features for review.
 - 2. Performance Requirements:
 - a. Model 5735SS
 - b. Part No. 1.109-656.0
 - c. GPM 8.0
 - d. PSI 3000
 - e. HP 20
 - f. Volts/Ph 460/3
 - g. Amps 21
 - h. Fuel NG

- i. BTU/Hr 720,450
 - j. Pump Model HX9536L. 2
 - k. Hose (FT) 50
 - l. Dimensions (LxWxH) 51"x31"x63.4"
 - m. Ship Wt (LBS) 1,471
- 3. Features
 - a. Upright, vertical coil delivers high efficiency and maintains constant temperature using oil, natural gas or liquid propane.
 - b. Controls for the pump, burner and detergent are easily accessible.
 - c. Remote ready for operation in wash bays.
 - d. Adjustable upstream detergent injection ensures high-pressure sudsing for better cleaning.
 - e. Stainless steel coil skin provides extra durability to withstand overspray.
 - f. Elevated gas valve protects valve from water damage, and is located at the back corner for easy installation and service.
 - g. Burner assembly pivots down to allow access to burner ring and pilot assembly for maintenance.
 - h. Insulated trigger gun and insulated wand with ergonomic, adjustable side handle.
 - i. Control panel provides access to the main controls. Remove the front panel to access the Smart Relay for secured control of desired operating settings, such as auto start/stop functionality.
 - j. Sleek side and front panels are easily removed for routine maintenance and service access.
 - k. 50-ft. length of high-pressure hose for easy maneuverability around a large working area.
 - l. Quick disconnect stainless steel nozzles are color coded for quick changing between 0°, 15°, 40° spray nozzles
 - m. Remote, hard-wired control switch with three switches: Pump, Burner, Detergent
- 4. Options to be provided:
 - a. Wall Mount Remote Kit (3).
 - b. Soap Solenoid and Switch.
 - c. Water Inlet Solenoid.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Coordinate location of rough-in work and utility stub-outs to assure match equipment to be installed.

3.02 INSTALLATION, GENERAL

- A. Remove existing equipment, package all components for reinstallation, protect it and return it to the City.
- B. Perform installation work under direct supervision or foreman of Construction Superintendent with authority coordinate related work.

1. Rough-in electrical connections.
2. Rough-in fuel connections
3. Positioning: Place equipment in accordance with Drawings and any special manufacturer requirements.
4. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
5. Anchorage: Attach equipment in accordance with manufacturer's written instructions and install fasteners shall be installed to avoid scratching or damaging equipment and adjacent surfaces

3.03 CLEANING

- A. Touch up damaged paint finishes.
- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation, and remove packing and installation debris from job site.
- D. Notify designated representative for acceptance inspection.

3.04 DEMONSTRATION

- A. Train the City's maintenance personnel to adjust, operate, and maintain each piece of equipment.

PART 4 - MEASUREMENT AND PAYMENT

- A. Shop Service Equipment as specified herein shall be included in the measurement and payment for "Equipment".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

JM TEST SYSTEMS, LLC

7323 TOM DRIVE BATON ROUGE, LA 70806

1-800-353-3411

www.jmtest.com/test-bench www.jmtest.com

Quote Reference Number:

TBE-22-2512-04

12/22/2023

Port Of Long Beach

Long Beach, CA

Manny Hernandez

562-283-7308

manuel.hernandez@polb.com

ELECTRICAL TEST BENCH QUANTITY: 1

*Panel Console w/ Test Equipment	\$ 50,604.00
*Calibration/ Certification (25% discount)	\$ 573.00
*Tabletop Setup w/ Cabinets & Access.	\$ 10,322.00
*Accessories	\$ 1,178.00
*Adjustable Motor Cart	\$ 9,826.00

*Est. Freight to 725 Harbor Plaza Dr, Long Beach, CA \$ 1,500.00

TOTAL IN US DOLLARS: \$ 74,003.00

Quote's good for 30 Days

Lead Time 16-20 Weeks

****This quote is for a quantity of 1 Electrical Test Bench(es)****

Electrical Components:

****Main input power: 480 VAC, 3P, 60Hz****

****Secondary input power: 120 VAC, 60Hz provided by 480V x 120V, 7.5 kVA stepdown transformer****

(100)*100A Disconnect Switch: 600 VAC max 3 pole 100A enclosed safety disconnect switch

(102)*100A Load Center: 240 VAC max 1P, 60 Hz, 100A, NEMA Type 3R enclosed load center with main breaker and needed circuit breakers installed at required amps

(104)*480V 3P Motor Starter: 480V 3P motor controller panel mounted/ SIZE 2/ IEC/ Max amperage: 32A/ Max horsepower: 20HP/ Includes four panel mounted cam-lok receptacles (three lines & ground), adjustable overload relay, main power switch, jog/run switch, start button, stop button, emergency stop button, & run light (Equipped with power analyzer)

(107)*Motor Starter Remote Start: Remote box connected to motor starter with start and stop button for operating from a safe distance

(113)*Cooling Fan: 2A thermostat (32 to 140 degrees F) connected to a 4-1/2" 3,000 RPM fan with an airflow of 110 CFM(Not in Drawing)

(115)*Metered 120 VAC Outlet: 120 VAC, 20A GFCI receptacle panel mounted (Equipped with power analyzer)

(121)*24 VDC Fixed Supply: Equipped with banana jacks & fuse with continuous 24 VDC supply

Meters & Calibrators:

(201)*Variable DC Power Supply: 30VDC/ 5A single variable output. Features include low output noise (1 mVrms), over voltage and over current protection, LCD display with backlight, standby output for safety, save-and-recall function up to three memory states, & keypad lock. Panel mounted

(210B)*AC/DC Power Supply: Variable AC/DC output in 6 nominal ranges 0-140VAC @ 20A, 0-280VAC @ 10A, 0-560VAC @ 5A/ 0-120VDC @ 16A, 0-240VDC @ 8A, 0-480VDC @ 4A. Vernier provides variable output. Input power protected by 20A circuit breaker. Equipped with volt meter. Panel mounted(20" deep console required)

(215)*Digital Panel Analyzer: Panel mounted digital meter connected to a current transformer. Capable of displaying current, voltage, amps, & watts

Calibration & Certification:

****All instruments are calibrated traceable to NIST. We are accredited by A2LA to comply with ISO 17025 standards. Certifications are good for one year****

Tabletop Setup:

****Panel, table top, & cabinet setup****

*Table Top: 1-3/4" thick 3' hardwood counter top covered in 3/16" neoprene black rubber with PVC angle trim

*Cabinets: 22.5" W, (1) 5 drawer & (1) 3 drawer high density cabinets mounted under table top

****Cabinets will be mounted on heavy duty swivel wheels****

(400)*Vise: Heavy duty vise with 6-1/2" jaw opening. Will be table top mounted

Construction Specifications:

*Console is made up of a heavy duty aluminum framing and high impact Kydex® panels. The front panel is made up of durable PVC and high impact formica laminate

*It is recommended that the test bench be kept inside in a climate controlled area and never in direct sunlight. Test bench should never be stored in any area that may exceed 100 degrees Fahrenheit (38 degrees Celsius) in temperature for a long period of time.

Accessories:

(500)*Test Lead Kit: Assorted test leads, T/C wire kits (qty 2 each of J, K, T, & E with 5' of wire)

(501)*Motor Starter Test Leads: 15' test lead wires with cam-lok plugs on one end and booted 100A alligator clamps on the other end

SECTION 14 47 00

WORKSTATION CRANES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies Workstation cranes:
 - 1. Freestanding Workstation Bridge Crane
 - 2. Accessories, including overhead hanger assemblies, runways, bridge moving perpendicular to runways and equipped with enclosed track, end trucks, hoist trolley, festooning systems, bumpers, and other accessories.

1.02 DEFINITIONS

- A. Workstation Crane: A crane spanning over a defined work area used to move materials both vertically and horizontally, utilizing a system of a beam, hoist, wire ropes or chains, for lifting and relocating heavy objects within its reach.
- B. Bridge Crane: consists of two parallel rails seated on longitudinal I-beams attached to opposite steel columns by means of brackets. The traveling bridge spans the gap.
- C. Hoist: the lifting or lowering component of a crane, travels along the bridge, lifting a load by means of a drum or lift-wheel around which rope or chain wraps.
- D. Festoon trolleys: Festoon trolleys are mobile supports for electrical cables or pneumatic and hydraulic lines that allow the cable to move with a hoist, trolley, or other mobile equipment.

1.03 SUBMITTALS

- A. Product data for crane and all accessories, indicating capacities, performance, standard operations, and applied forces to foundation.
- B. Bridge Crane Shop drawings that outline crane configuration, dimensions, construction, and installation details.
- C. Manufacturer's Installation Instructions
- D. Manufacturer's Operation and Maintenance Manual
- E. Manufacturer warranty.

1.04 QUALITY ASSURANCE

- A. Standard cranes shall be designed, fabricated, and installed in accordance with ANSI B30.11, MH27.2, OSHA 1910.179, and International Building Code.
 - 1. Design to withstand the worst seismic condition in the continental U.S. as defined by the IBC.
- B. Installer's Qualification: A company that is acceptable to the crane manufacturer and with five years of experience assembling and installing cranes for multiple applications. Installer should be able to:
 - 1. Perform welding using certified welders in accordance with AWS D1.1.
 - 2. Bolt connections in accordance with torque tightening procedures specified in AISC Manual, Part 5.

3. Clearly label crane with rated load capacity with label visible from floor level and loading position.
4. Perform OSHA Load Test Certification.

1.05 DESIGN REQUIREMENTS

- A. Modular, Pre-Engineered Design: Capable of expansion, disassembly, relocation, and the addition of multiple mixed capacity bridges, designed, fabricated, and installed in accordance with ANSI B30.11 and OSHA 1910.179.
- B. Coverage: Rectangular area as indicated on Drawings, including:
 1. Overhead hanger assemblies (no support structures required in crane operating area).
 2. Two rigid, parallel runways; cranes with more than two runways or with articulating runways are not acceptable.
 3. Rigid single or double girder bridge moving perpendicular to runways or monorail.
- C. Criteria:
 1. Productivity Ratio: manually move load with maximum force of approximately 1/100 load weight,
 2. Deflection Guidelines: maximum deflection of approximately L/450.
 3. Crane Operating Temperature: 5 to 200 degrees F (-15 to 93 C)
- D. Structural Design: based on live load capacity plus 15 percent for hoist and trolley weight and 25 percent for impact. Crane shall be designed to withstand:
 1. Crane and hoist dead load.
 2. Live load capacity equal to net rated hook load.
 3. Inertia forces from crane and load movement.

1.06 WARRANTY

- A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".
- B. Manufacturer's Warranty: Included on manufacturer's standard form and outlines the manufacturer's agreement to repair or replace assemblies and components that fail in materials and/or execution within warranty period from date of substantial completion.
 1. Warranty covers defects in equipment material and workmanship of manual systems and equipment for ten (10) years or 20 thousand (20,000) hours, commencing on the date of shipment to the first retail purchaser. This warranty extends to non-wearable parts only, with the exception of the wheels supplied on manually operated workstation end trucks and hoist trolleys.
 2. Warranty covers two (2) years for paint and finishes for non-aluminum components.
 3. Warranty covers one (1) year for motorized systems and equipment

1.07 DELIVERY AND STORAGE

- A. Deliver materials to the job site in their original unopened packages, clearly marked with the manufacturer's name, brand name, and description of contents.
- B. Store materials in clean, dry areas, away from excessive heat, sparks, and open flame.
- C. Store and dispose of solvent-based materials in accordance with requirements of local authorities.

1.08 COORDINATION

- A. Coordinate installation with the work of other trades.

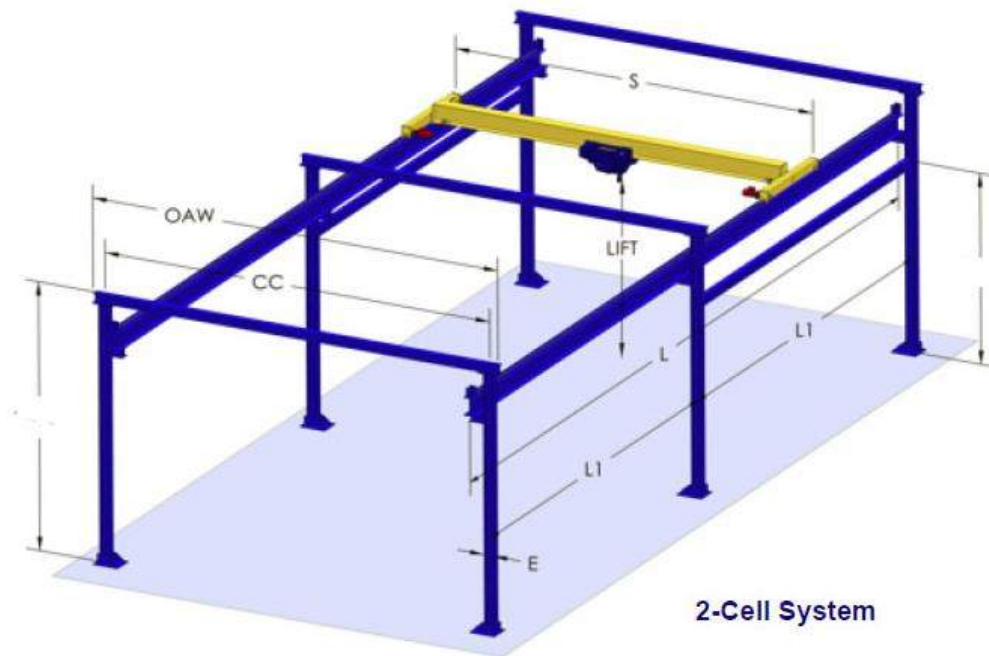
1.09 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Institute of Steel Construction (AISC):
 -Manual of Steel Construction, Part 5, Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts
- C. American National Standards Institute (ANSI):
 - ANSI B30.11Monorails and Underhung Cranes
- D. American Society for Testing and Materials (ASTM)
 - A36:Carbon Structural Steel
 - A325:Structural Bolts, Steel, Heat Treated, 120/150 ksi Minimum Tensile Strength
 - A490:Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
 - B221:Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube
- E. American Welding Society (AWS)
 - D1.1:Structural Welding Code
 -Certified Shop
- F. Occupational Safety and Health Administration (OSHA) –
 -Specification 1910.179: Overhead and Gantry Cranes
- G. CMAA Specifications
 - 70 and 74:Travelling Bridge Cranes
- H. MMA Specification
 - MH27.2:Enclosed Track Underhung Cranes and Monorail Systems

PART 2 - PRODUCTS

2.01 CUSTOM FREESTANDING 2-BAY OVERHEAD BRIDGE CRANE

- A. Configuration Requirements:
 - 1. Layout and dimensions as indicated on Drawings. Approximate 54 by 30 ft. lift bay.
 - 2. Lift Capacity: 2 ton
 - 3. Overall Width (OAW): 30' and Crane Girder Span (S): 26'-10"
 - 4. Lift Height: maximize available height, 19 ft presumed minimum.
 - 5. Electric operation for crane beam and trolley with remote control.
 - 6. Electric chain hoist, minimum 2 ton capacity as noted in Part 2.3 below.
- B. Design Factors: Cranes shall be designed with a factor of 15 percent of the rated capacity for hoist and trolley weight and 25 percent of the rated capacity for impact.
- C. Service Factor: designed for moderate usage (Class C Normal/Industry service) as defined:
 - 1. System or equipment is used where lifted loads average 50 percent of the rated capacity with five to ten lifts per hour, averaging 15 feet, not over 50 percent of the lifts at rated capacity.
- D. Construction: completely shop fabricated and finished for field assembly without field modification.



2.02 PREPACKAGED FREESTANDING 2-BAY OVERHEAD BRIDGE CRANE

- A. Basis of Performance Product: LK Goodwin Model 0203060-2, #114511
<https://shop.lkgoodwin.com/product/0203060-complete-free-standing-overhead-bridge-crane/114511> Submit product of equal performance for review.
1. Lift Capacity: 2 ton
 2. Overall Width (OAW): 30'
 3. Crane Girder Span (S): 26'-10"
 4. Lift Height: 16'-11.25"
 5. Column Size: 6.375 inch square.
 6. Electric motorized operation for crane beam and trolley with remote control.
 7. Electric chain hoist, minimum 2 ton capacity as noted below.

2.03 ELECTRIC CHAIN HOIST

- A. Basis Of Performance Product: GORBEL Electric Chain Hoist, GECH-2-S-8-230-P, model #94506
https://www.lkgoodwin.com/more_info/gs_series_hoists/gs_series_hoists.shtml . Submit product of equal performance for review.
1. 2 ton Capacity Type 070/61 Single Speed, 2 fall
 2. Voltage: 230v-3phase-60 Hz, 1.9 amp draw, 1.22 HP motor.
 3. Hoisting Speed (Published): 8 fpm; 20 ft lift height, Canvas chain container
 4. Suspension: DSP Double Hole Suspension Plate,



Pendant Handle

Ergonomic control pendant requires low operator force and is equipped complete with E-stop.

- B. Provide product that meets or exceeds the Basis of Design minimum service capabilities and service life, approved by the City.

2.04 SHOP FINISHING

- A. Surface Preparation and Painting Procedures:
 1. Comply with Society for Protective Coatings (SSPC) for all product surface preparation.
 2. Deburred and descaled using power tools equipped with sanding discs and wire wheels prior to painting.
- B. Standard Paint Colors:
 1. All components are coated with quick drying, semi-gloss enamel, applied to a minimum dry-film thickness of two to three mils. Factory standard enamel in standard
 2. Aluminum Components: Brushed aluminum finish or enamel.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify support by others is complete, and finishes are cured and clean.
- B. Verify attachment points are compliant with loading requirements.

3.02 PROTECTION OF ADJACENT SURFACES

- A. Protect adjacent surfaces from incidental damage.

3.03 BRIDGE CRANE INSTALLATION

- A. Units and accessories must be installed in accordance with manufacturer's instructions and shop drawings.
- B. Crane components shall not be modified without manufacturer's approval.
- C. Clearances for moving crane components:
 1. Minimum vertical clearance: Three inches (76 mm) from any overhead obstruction.
 2. Minimum horizontal clearance: Two inches (51 mm) from any lateral obstruction.
 3. Prior to applying proper torque to the bolts, ensure runways are:
 - a. Level to within 1/8 inch in 20 feet (3 mm in 6.1 m).
 - b. Parallel with opposite runway to within plus or minus 1/8 inch every 20 feet (3 mm in 6.1 m).
- D. Runway Installation

1. Runways should extend as indicated on shop drawings. Festoon storage may extend beyond last support.
 2. Runway end stops must be aligned longitudinally so bridge hits end stops simultaneously.
- E. Runway End Stop Installation
1. Secure end stop assemblies, end stop bolts, and locknuts at both ends of runway tracks, except for end of festoon storage area, where applicable.
- F. Festoon Track Extension Installation
1. Install festoon trolleys and cable in runway. Use the following trolley spacing:
 - a. Bridges: 18-inch loops, approximately
 - b. Runways and Monorails: 36-inch loops, approximately
 2. Ensure trolleys slide across runway and festoon track extension joint smoothly.
 3. Ensure all trolleys stack properly in festoon track extension area, clear through bolts, and contact end stop.
- G. Runway Festoon Installation
1. Install festoon trolleys into storage area of runway track if system includes festooning.
 2. Secure end stop bolts and rubber bumpers.
 3. Locate and secure festoon end clamps. Install festoon cable on festoon trolleys at equal spacing. Locate festooning at end of the runway indicated on Drawings.
- H. Hoist Trolley and Bridge Festoon Installation
1. Install hoist trolley and festoon trolleys on bridge track. Secure end stop bolts and rubber bumpers. Install festoon cable on festoon trolleys at equal spacing.
 2. End stop must be installed with through bolts securely in place before operating.
 3. Once installation is completed, the bridge and runways should be leveled. On droprods, install lateral and longitudinal sway bracing. The total system should be checked for tightness of all nuts and bolts.
- I. Ensure all warning labels are in place.

3.04 FIELD QUALITY CONTROL

- A. Perform field quality control testing as recommended by manufacturer.
- B. Inspection: Verify all bolts are tightened to torque values specified in manual and lock washers are fully compressed.
- C. Field Test:
1. Ensure crane operates properly (movement is smooth and consistent).
 2. Verify motorized operation and controls function properly.
 3. Make adjustments as needed and correct inadequacies.
- D. Acceptance Test for enclosed track units: After the crane system has been installed, perform OSHA required acceptance test before operating and after any modifications. An authorized dealer or installer should perform acceptance tests.
- E. Maintenance
1. Perform a system inspection 30 days after start of use. All nuts, bolts, and screws should be checked for tightness. All end stops, cotter pins, and hoist trolleys should be checked for abnormal wear or breakage. Check track splices for alignment and verify that end trucks and festoon trolleys travel smoothly through joints. Check that festoon cables and hoses are securely clamped to festoon trolleys and end clamps.
 2. Perform a complete inspection of all fasteners and connections after one year of use. Heavy conditions of use may require more frequent User inspections.

3. Operators should visually inspect the system before each use to note any unusual or abnormal system operations.
- F. Keep surfaces clean and clear of build-up and residue.
 1. Protect installed products until completion of project.
 2. Touch up, repair, or replace damaged products before substantial completion.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Equipment*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 21 05 17

SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves without waterstop.
 - 2. Sleeve-seal systems.
 - 3. Grout.
 - 4. Silicone sealants.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 SLEEVES WITHOUT WATERSTOP

- A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

2.02 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, LLC.
 - 2. GPT; a division of EnPRO Industries.
 - 3. Metraflex Company (The).
 - 4. Approved Equal
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Designed to form a hydrostatic seal of 20 psig minimum.
 - 2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.

3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

2.03 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.04 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

3.02 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - 2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.04 SLEEVE SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sleeves and Sleeve Seals for Fire-Suppression Piping as specified herein shall be included in the measurement and payment for "Fire Alarm and Sprinklers".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 21 05 18

ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. Keeney Manufacturing Company (The).
 - 4. Approved Equal

2.02 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.03 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID (Inner Diameter) to closely fit around pipe, tube, and insulation of piping and with OD (Outer Diameter) that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping to Remain:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
- C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD (Outer Diameter) that completely covers opening.
 - 1. New Piping: Split floor plate.
 - 2. Existing Piping: Split floor plate.

3.02 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

PART 4 - MEASUREMENT AND PAYMENT

- A. Escutcheons for Fire-Suppression Piping as specified herein shall be included in the measurement and payment for "Fire Alarm and Sprinklers".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 21 05 23

GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Iron butterfly valves with indicators.
 - 2. Check valves.
 - 3. Iron OS&Y (Outside Screw and Yolk) gate valves.
 - 4. Trim and drain valves.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain each type of valve from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
 - 1. Fire Main Equipment: HAMV (UL Mark)- Main Level.
 - a. Indicator Posts, Gate Valve: HCBZ (UL Mark) - Level 1.
 - b. Ball Valves, System Control: HLUG (UL Mark) - Level 3.
 - c. Butterfly Valves: HLXS (UL Mark) - Level 3.
 - d. Check Valves: HMER (UL Mark) - Level 3.
 - e. Gate Valves: HMRZ (UL Mark) - Level 3.
 - 2. Sprinkler System and Water Spray System Devices: VDGT (UL Mark) - Main Level.
 - a. Valves, Trim and Drain: VQGU (UL Mark) - Level 1.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - 1. Automated Sprinkler Systems:
 - a. Valves.

- 1) Gate valves.
- 2) Check valves
- 3) Miscellaneous valves.

C. ASME Compliance:

1. ASME (American Society of Mechanical Engineers) B1.20.1 for threads for threaded-end valves.
2. ASME (American Society of Mechanical Engineers) B16.1 for flanges on iron valves.
3. ASME (American Society of Mechanical Engineers) B31.9 for building services piping valves.

D. AWWA (American Water Works Association) Compliance: Comply with AWWA (American Water Works Association) C606 for grooved-end connections.

E. NFPA (National Fire Protection Association) Compliance for valves:

1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS (Nominal Pipe Size) 2 and smaller.

2.03 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. NIBCO INC.
2. Viking Group Inc.
3. Zurn Industries, LLC.
4. Approved Equal

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
 - 1. Section 21 13 13 "WET-PIPE SPRINKLER SYSTEMS" for application of valves in wet-pipe, fire-suppression sprinkler systems.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.
- C. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above the pipe center.
- E. Install valves in position to allow full stem movement.
- F. Install valve tags. Comply with requirements in Section 21 05 53 "IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

PART 4 - MEASUREMENT AND PAYMENT

- A. General-Duty Valves for Water-Based Fire Suppression Piping as specified herein shall be included in the measurement and payment for "Fire Alarm and Sprinklers".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal hanger-shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS (American Welding Society) D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design trapeze pipe hangers and equipment supports.

- B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 (American Society of Civil Engineers).
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. NFPA (National Fire Protection Association) Compliance: Comply with NFPA 13.
- D. UL Compliance: Comply with UL 203.

2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS (Manufacturers Standardization Society SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved (National Fire Protection Association), UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved (National Fire Protection Association), UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.05 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS (Manufacturers Standardization Society) SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- E. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- H. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME (American Society of Mechanical Engineers) B31.9 for building services piping.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS (American Welding Society) D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "EXTERIOR PAINTING" and Section 09 91 23 "INTERIOR PAINTING."

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA (National Fire Protection Association) requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- E. Horizontal-Piping Hangers and Supports: Comply with NFPA (National Fire Protection Association) requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS (Manufacturers Standardization Society) Type 1): For suspension of noninsulated or insulated, stationary pipes NPS (Nominal Pipe Size) 1/2 to NPS (Nominal Pipe Size) 30.
 - 2. Steel Pipe Clamps (MSS (Manufacturers Standardization Society) Type 4): For suspension of NPS (Nominal Pipe Size) 1/2 to NPS (Nominal Pipe Size) 24 if little or no insulation is required.

3. Adjustable, Swivel-Ring Band Hangers (MSS (Manufacturers Standardization Society) Type 10): For suspension of noninsulated, stationary pipes NPS (Nominal Pipe Size) 1/2 to NPS (Nominal Pipe Size) 8.
 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS (Manufacturers Standardization Society) Type 11): For suspension of noninsulated, stationary pipes NPS (Nominal Pipe Size) 3/8 to NPS (Nominal Pipe Size) 8.
 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS (Manufacturers Standardization Society) Type 12): For suspension of noninsulated, stationary pipes NPS (Nominal Pipe Size) 3/8 to NPS (Nominal Pipe Size) 3.
 6. U-Bolts (MSS (Manufacturers Standardization Society) Type 24): For support of heavy pipes NPS (Nominal Pipe Size) 1/2 to NPS (Nominal Pipe Size) 30.
 7. Pipe Saddle Supports (MSS (Manufacturers Standardization Society) Type 36): For support of pipes NPS (Nominal Pipe Size) 4 to NPS (Nominal Pipe Size) 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 8. Pipe Stanchion Saddles (MSS (Manufacturers Standardization Society) Type 37): For support of pipes NPS (Nominal Pipe Size) 4 to NPS (Nominal Pipe Size) 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 9. Adjustable Pipe Saddle Supports (MSS (Manufacturers Standardization Society) Type 38): For stanchion-type support for pipes NPS (Nominal Pipe Size) 2-1/2 to NPS (Nominal Pipe Size) 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS (Manufacturers Standardization Society) Type 8): For support of pipe risers NPS (Nominal Pipe Size) 3/4 to NPS (Nominal Pipe Size) 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS (Manufacturers Standardization Society) Type 42): For support of pipe risers NPS (Nominal Pipe Size) 3/4 to NPS (Nominal Pipe Size) 24 if longer ends are required for riser clamps.
- G. Hanger-Rod Attachments: Comply with NFPA requirements.
- H. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS (Manufacturers Standardization Society) Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. C-Clamps (MSS (Manufacturers Standardization Society) Type 23): For structural shapes.
 3. Side-Beam Brackets (MSS (Manufacturers Standardization Society) Type 34): For sides of steel or wooden beams.
- I. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS (Manufacturers Standardization Society) Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS (Manufacturers Standardization Society) Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- J. Comply with NFPA (National Fire Protection Association) requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

PART 4 - MEASUREMENT AND PAYMENT

- A. Hangers and Supports for Fire-Suppression Piping and Equipment as specified herein shall be included in the measurement and payment for "Fire Alarm and Sprinklers".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 21 05 53

IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

PART 2 - PRODUCTS

2.01 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Brady Corporation.
 - 2. LEM Products Inc.
 - 3. Seton Identification Products; a Brady Corporation company.
 - 4. Approved Equal
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME (American Society of Mechanical Engineers) A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3 – Execution, herein.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- F. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
1. Pipe size.
 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
 3. Lettering Size: Size letters in accordance with ASME (American Society of Mechanical Engineers) A13.1 for piping.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.03 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "INTERIOR PAINTING."
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Within 3 ft. of each valve and control device.
 2. At access doors, manholes, and similar access points that permit a view of concealed piping.
 3. Within 3 ft. of equipment items and other points of origination and termination.
 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.
- D. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Fire-Suppression Pipe Label Color Schedule:

1. Fire-Suppression Pipe Labels: White letters on an ANSI (American National Standards Institute) Z535.1 safety-red background.

PART 4 - MEASUREMENT AND PAYMENT

- A. Identification for Fire-Suppression Piping and Equipment as specified herein shall be included in the measurement and payment for "Fire Alarm and Sprinklers".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Steel pipe and fittings.
 - 2. Sprinkler piping specialties.
 - 3. Specialty valves.
 - 4. Sprinklers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Delegated Design Submittals: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Qualification Data: For qualified Installer and NICET certified technician.
- C. Design Data: Approved sprinkler piping working plans, prepared according to NFPA 13, including documented approval by authorities having jurisdiction, and including hydraulic calculations if applicable.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- E. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by qualified professional engineer.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. All devices and components must be FM Approved.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Sprinkler system equipment, specialties, accessories, installation, and testing to comply with NFPA 13.
- D. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design wet-pipe sprinkler systems.
 - 1. Refer to Drawings for flow test information
 - 2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 3. Sprinkler Occupancy Hazard Classifications:
 - a. Refer to Drawings
 - 4. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Refer to Drawings
 - 5. Maximum protection area per sprinkler according to UL listing and FM Approvals Guide.
 - 6. Maximum Protection Area per Sprinkler:
 - a. Refer to Drawings
- F. Obtain documented approval of sprinkler system design from authorities having jurisdiction.

2.02 STEEL PIPE AND FITTINGS

- A. Standard-Weight Steel Pipe: black-steel pipe, ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Steel Pipe Nipples: black-steel pipe, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- C. Steel Couplings: uncoated steel, ASTM A865/A865M, threaded.
- D. Malleable- or Ductile-Iron Unions: UL 860.
- E. Cast-Iron Flanges: ASME (American Society of Mechanical Engineers) 16.1, Class 125.
- F. Steel Flanges and Flanged Fittings: ASME (American Society of Mechanical Engineers) B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: AWWA (American Water Works Association) C110, rubber, flat face, 1/8 inch thick or EPDM (Ethylene propylene diene monomer) rubber gasket.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
- G. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Anvil; an ASC Engineered Solution.
 - b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Victaulic Company.
 - d. Approved Equal
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Grooved-End Fittings for Steel Piping: Painted grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM (Ethylene propylene diene monomer) -rubber gasket, and bolts and nuts.
- H. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.03 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
 - 1. Standard: UL 213.
 - 2. Pressure Rating: 175-psig minimum.

3. Body Material: Ductile-iron housing with EPDM (Ethylene propylene diene monomer) seals and bolts and nuts.
 4. Type: Mechanical-tee and -cross fittings.
 5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 7. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Adjustable Drop Nipples:
1. Standard: UL 1474.
 2. Pressure Rating: 250-psig minimum.
 3. Body Material: Steel pipe with EPDM (Ethylene propylene diene monomer) -rubber O-ring seals.
 4. Size: Same as connected piping.
 5. Length: Adjustable.
 6. Inlet and Outlet: Threaded.

2.04 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" and FM Global's "Approval Guide."
- B. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element:
1. Nonresidential Applications: UL 199.
 2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6 or 8.0, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Sprinkler Finishes: Chrome plated.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
- G. Sprinkler Guards:
1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.05 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" and FM Global's "Approval Guide."
- B. Specialty Valves Pressure Rating: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.

- E. End Connections: Flanged or grooved.
- F. Automatic (Ball Drip) Drain Valves:
 - 1. Standard: UL 1726.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Type: Automatic draining, ball check.
 - 4. Size: NPS (Nominal Pipe Size) 3/4
 - 5. End Connections: Threaded.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING

- A. Locations and Arrangements: Drawing, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on Shop Drawings.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Engineer before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS (Nominal Pipe Size) 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS (Nominal Pipe Size) 2-1/2 and larger end connections.
- F. Install sprinkler piping with drains for complete system drainage.
- G. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- H. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- I. Fill sprinkler system piping with water.
- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING."
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING."

- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING."

3.02 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS (Nominal Pipe Size) 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS (Nominal Pipe Size) 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME (American Society of Mechanical Engineers) B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME (American Society of Mechanical Engineers) B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA (American Water Works Association) C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA (American Water Works Association) C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA (American Water Works Association) C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA (American Water Works Association) C606 for steel-pipe grooved joints.
- J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.03 INSTALLATION OF VALVES AND SPECIALTIES

- A. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

3.04 INSTALLATION OF SPRINKLERS

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

3.05 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.06 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.07 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.08 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-Pressure, Wet-Pipe Sprinkler System, NPS (Nominal Pipe Size) 2 and Smaller, to Be One of the Following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-Pressure, Wet-Pipe Sprinkler System, NPS (Nominal Pipe Size) 2-1/2 to NPS (Nominal Pipe Size) 4, to Be One of the Following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.09 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Pendent sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Upright and Pendent Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Fire Alarm and Sprinklers*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

1.03 DEFINITIONS

- A. NEMA: National Electrical Manufacturers Association

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 100 deg F and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- C. Motors 1/20 HP and Smaller: Shaded-pole type.
- D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

- A. Common Motor Requirements for Plumbing Equipment as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves without waterstop.
 - 2. Sleeves with waterstop.
 - 3. Sleeve-seal systems.
 - 4. Grout.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 DEFINITIONS

1.05 TIONS

- A. ASTM: American Society for Testing and Materials
- B. EPDM: Ethylene propylene diene monomer
- C. ID: Inner diameter

PART 2 - PRODUCTS

2.01 SLEEVES WITHOUT WATERSTOP

- A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends.
- B. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

2.02 SLEEVES WITH WATERSTOP

- A. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- B. Description: Manufactured, galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Designed to form a hydrostatic seal of 20 psig minimum.
 - 2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.

- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
- 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "PENETRATION FIRESTOPPING."

3.02 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeves.

3.03 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - 2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.05 SLEEVE SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops.
 - 4. Interior Partitions:
 - a. Sleeves without waterstops.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sleeves and Sleeve Seals for Plumbing Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.02 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. ID: Inner diameter
- C. OD: Outer diameter

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
2. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split-casting, stamped steel with concealed hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

3.02 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

PART 4 - MEASUREMENT AND PAYMENT

- A. Escutcheons for Plumbing Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 19

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Thermometers, liquid in glass, lead free.
 - 2. Thermowells, lead free.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Thermometers, bimetallic actuated, lead free.
 - 2. Thermometers, liquid in glass, lead free.
 - 3. Thermowells, lead free.
 - 4. Pressure gauges, dial type, lead free.
 - 5. Gauge attachments, lead free.
- B. Product Data Submittals: For each type of product.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

1.04 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. NPS: Nominal pipe size
- D. NSF: National Sanitation Foundation

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. All items in this Section in contact with water for human consumption, are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with

NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.02 THERMOMETERS, LIQUID IN GLASS, LEAD FREE

A. Thermometers, Liquid in Glass, Lead Free - Metal Case, Industrial Style:

1. Source Limitations: Provide liquid-in-glass, lead-free, metal-case, industrial-style thermometers from single manufacturer.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid, mercury free.
6. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
10. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

2.03 THERMOWELLS, LEAD FREE

A. Thermowells, Lead Free:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper.
4. Material for Use with Steel Piping: Type 304 stainless steel or Type 316 stainless steel
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend to match thermometer stem length.
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond the finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install thermometer with thermowell at each required thermometer location.
- B. Install thermowells in vertical position in piping tees.
- C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- D. Install thermowells with extension on insulated piping.
- E. Fill thermowells with heat-transfer medium.
- F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- G. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.

3.02 CONNECTIONS

- A. Install meters adjacent to machines and equipment to allow service and maintenance of meters, machines, and equipment.

3.03 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters to proper angle for best visibility.

3.04 THERMOMETER, LEAD FREE, SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping:
 - 1. 0 to 100 deg F.
- B. Scale Range for Domestic Hot-Water Piping:
 - 1. 0 to 250 deg F.

PART 4 - MEASUREMENT AND PAYMENT

- A. Meters and Gauges for Plumbing Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 23.12

BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. AWWA: American Water Works Association
- D. EPDM: Ethylene propylene diene monomer
- E. IAPMO: International Association of Plumbing and Mechanical Officials
- F. MSS: Manufacturers Standardization Society
- G. NPS: Nominal pipe size
- H. NSF: National Sanitation Foundation
- I. PTFE: Polytetrafluoroethylene
- J. RPTFE: Reinforced Polytetrafluoroethylene

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Standards:
 - 1. Domestic water valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act, with requirements of authorities

having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
7. ASME B16.34 for flanged and threaded end connections
8. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Type:

1. Hand Lever: For quarter-turn valves smaller than NPS 4.

G. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRASS BALL VALVES

A. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Standard: MSS SP-110; MSS SP-145.
2. CWP Rating: 600 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass.
5. Ends: Threaded or soldered.
6. Seats: PTFE.
7. Stem: Brass.
8. Ball: Chrome-plated brass.
9. Port: Full.

B. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Press Ends:

1. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
2. CWP Rating: Minimum 200 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass.

5. Ends: Press.
6. Press-End Connections Rating: Minimum 200 psig.
7. Seats: PTFE or RPTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.
11. O-Ring Seal: Buna-N or EPDM.

2.03 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:
 1. Standard: MSS SP-110; MSS SP-145.
 2. CWP Rating: 600 psig.
 3. Body Design: Two piece.
 4. Body Material: Bronze.
 5. Ends: Threaded or soldered.
 6. Seats: PTFE.
 7. Stem: Bronze or brass.
 8. Ball: Chrome-plated brass.
 9. Port: Full.
- B. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Press Ends:
 1. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
 2. CWP Rating: Minimum 200 psig.
 3. Body Design: Two piece.
 4. Body Material: Bronze.
 5. Ends: Press.
 6. Press-End Connections Rating: Minimum 200 psig.
 7. Seats: PTFE or RTPFE.
 8. Stem: Bronze or brass.
 9. Ball: Chrome-plated brass.
 10. Port: Full.
 11. O-Ring Seal: EPDM or Buna-N.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.

- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.02 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.
- B. Provide support to piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access.
- D. For valves in horizontal piping, install valves with stem at or above center of pipe.
- E. Install valves in position to allow full valve actuation movement.
- F. Valve Tags: Comply with requirements in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT" for valve tags and schedules.
- G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.
- H. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

3.04 ENDS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE - 150 PSIG OR LESS

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Brass ball valves, two piece with full port, and brass trim.
3. Bronze ball valves, two piece with full port, and bronze or brass trim.
4. Bronze ball valves, two piece with regular port, and bronze trim.

3.06 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE - 150 TO 200 PSIG

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Brass ball valves, two piece with full port, and brass trim.
3. Bronze ball valves, two piece with full port, and bronze or brass trim.
4. Bronze ball valves, two piece with regular port, and bronze trim.

3.07 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Brass ball valve, one piece. Provide with threaded solder or press-connection-joint ends.
2. Bronze ball valve, one piece with bronze trim. Provide with threaded solder or press-connection-joint ends.
3. Brass ball valves, two piece with full port, and brass trim. Provide with threaded solder or press-connection-joint ends.
4. Bronze ball valves, two piece with full port, and bronze or brass trim. Provide with threaded solder or press-connection-joint ends.
5. Bronze ball valves, two piece with regular port, and bronze trim.

PART 4 - MEASUREMENT AND PAYMENT

- A. Ball Valves for Plumbing Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 23.14

CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Bronze, swing check valves.
 - 2. Bronze, swing check valves, press ends.

1.02 ACTION SUBMITTALS

- A. Product data: For each type of product.

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. AWWA: American Water Works Association
- D. EPDM: Ethylene propylene diene monomer
- E. MSS: Manufacturers Standardization Society
- F. NPS: Nominal pipe size
- G. NSF: National Sanitation Foundation
- H. PTFE: Polytetrafluoroethylene
- I. RPTFE: Reinforced Polytetrafluoroethylene

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Standards:
 - 1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges for metric standard piping.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for cast-copper solder joint.
 - 6. ASME B16.22 for wrought copper solder joint.
 - 7. ASME B16.51 for press joint.
 - 8. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for groove-end connections.
- D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE, SWING CHECK VALVES

- A. Bronze, Swing Check Valves with Bronze Disc, Class 125:
 - 1. Standard: MSS SP-80, Type 3.
 - 2. CWP Rating: 200 psig.
 - 3. Body Design: Horizontal flow.
 - 4. Body Material: ASTM B62, bronze.
 - 5. Ends: Threaded or soldered. See valve schedule articles.
 - 6. Disc: Bronze.
- B. Bronze, Swing Check Valves, Press Ends:
 - 1. Standard: MSS SP-80 and MSS SP-139.
 - 2. CWP Rating: Minimum 200 psig.
 - 3. Body Design: Horizontal flow.
 - 4. Body Material: ASTM B584, bronze.
 - 5. Ends: Press.
 - 6. Press Ends Connection Rating: Minimum 200 psig.
 - 7. Disc: Brass or bronze.

PART 3 - EXECUTION

3.01 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- D. Install valves so that stems are horizontal or slope upward from centerline of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and manual operator movement.
- G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
- H. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- I. Install valve tags. Comply with requirements in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT" for valve tags and schedules.
- J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.02 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze, swing check valves with bronze disc.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded, soldered, or press-end connections.
 - 2. For Steel Piping, NPS 2 and Smaller: Threaded.

3.04 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE - 150 PSIG OR LESS

- A. Pipe NPS 2 and Smaller:
 - 1. Horizontal and Vertical Applications: Bronze, swing check valves with bronze disc, Class 125, with soldered or threaded end connections.

3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze, swing check valves with bronze disc, Class 125, with soldered or threaded end connections.
 - 2. Bronze, swing check valves with press-end connections.

PART 4 - MEASUREMENT AND PAYMENT

- A. Check Valves for Plumbing Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal hanger-shield inserts.
 - 4. Fastener systems.
 - 5. Pipe-positioning systems.
 - 6. Equipment supports.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 DEFINITIONS

- A. ASCE: American Society of Civil Engineers
- B. ASME: American Society of Mechanical Engineers
- C. AWS: American Welding Society
- D. IAPMO: International Association of Plumbing and Mechanical Officials
- E. MSS: Manufacturers Standardization Society
- F. NPS: Nominal pipe size
- G. OD: Outer diameter

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- B. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-stainless-steel shapes, with MSS SP-58 stainless-steel hanger rods, nuts, saddles, and U-bolts.

2.04 THERMAL HANGER-SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

- B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-stainless steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.07 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from galvanized structural-carbon-steel shapes.

2.08 MATERIALS

- A. Aluminum: ASTM B221.
- B. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- C. Stainless Steel: ASTM A240/A240M.
- D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M stainless-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.

- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

- A. Fabricate galvanized structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.05 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "EXTERIOR PAINTING" & Section 09 91 23 "INTERIOR PAINTING."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use stainless-steel pipe hangers and stainless-steel attachments for stainless steel piping and tubing.
- F. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 13. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
 - 14. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
 - 15. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
 - 16. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

PART 4 - MEASUREMENT AND PAYMENT

- A. Hangers and Supports for Plumbing Piping and Equipment as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. NFPA: National Fire Protection Association
- D. OSHA: Occupational Safety & Health Administration

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
 - 2. Letter and Background Color: As indicated for specific application under Part 3.
 - 3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 1. Pipe size.
 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.

3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of plumbing equipment.
- B. Sign and Label Colors.
 1. White letters on an ANSI Z535.1 safety-green background.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

3.04 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Within 3 ft. of each valve and control device.
 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 3. Within 3 ft. of equipment items and other points of origination and termination.
 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

- C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe-Label Color Schedule:
 - 1. Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
 - 2. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 3. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
 - 4. Domestic Hot-Water Return Piping: White letters on an ANSI Z535.1 safety-green background.
 - 5. Sanitary Waste, indirect waste, and condensate drain Piping: White letters on a black background.
 - 6. Nonpotable Cold Water: Black letters on an ANSI Z535.1 safety-yellow background.
 - 7. Nonpotable Hot Water: Black letters on an ANSI Z535.1-yellow background.
 - 8. Compressed Air: White letters on an ANSI Z535.1 safety-blue background.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Plumbing*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3 Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 05 93

TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. TAB of domestic water system.
 - 2. TAB of plumbing equipment:
 - a. Domestic hot-water in-line circulation pumps.
 - b. General-duty air compressors.
 - 3. Pipe-leakage test verification.
 - 4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

1.02 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article herein.
- D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.04 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.
- E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.05 FIELD CONDITIONS

- A. Full City Occupancy: City will occupy the site and existing building during entire TAB period. Cooperate with City during TAB operations to minimize conflicts with City's operations.
- B. Partial City Occupancy: City may occupy completed areas of building before Substantial Completion. Cooperate with City during TAB operations to minimize conflicts with City's operations.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.
 - 1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Domestic Water System:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
 - b. Water heaters are installed and functioning.
 - c. Piping is complete and all points of outlet are installed.
 - d. Water treatment is complete.
 - e. Systems are flushed, filled, and air purged.
 - f. Strainers are clean.
 - g. Control valves are functioning in accordance with the sequence of operation.
 - h. Shutoff and balance valves are 100 percent open.
 - i. Hot-water circulating pump is operational and proper rotation is verified.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. Sanitary Sewage/Drainage System:
 - a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
 - b. Piping is complete.
 - c. Suitable access to equipment is provided.
 - 3. Compressed-Air System:
 - a. Leakage and pressure tests on compressed air distribution system have been satisfactorily completed in accordance with Division 22 requirements.
 - b. Piping is complete and all points of outlet are installed.
 - c. Systems are flushed, filled, and air purged.
 - d. Strainers are clean.
 - e. Shutoff and balance valves are 100 percent open.
 - f. Compressors are operational and of proper rotation.
 - g. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
 - h. Suitable access to balancing devices and equipment is provided,

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."
- C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Domestic water in-line pumps.
 - 3. Domestic water heaters.
 - 4. Air compressors.

3.05 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
 - 1. Check expansion tank for proper setting.
 - 2. Check water heater for proper discharge temperature setting.
 - 3. Check remotest point of outlet for adequate pressure.
 - 4. Check flow-control valves for proper position.
 - 5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 6. Verify that motor controllers are equipped with properly sized thermal protection.
 - 7. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

3.06 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

- A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:
 - 1. Check remotest point of outlet for adequate pressure.
 - 2. Check pressure-control valves for proper position.
 - 3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 4. Verify that motor controllers are equipped with properly sized thermal protection.
- D. Measure and record upstream and downstream pressure of pressure-reducing valves.
- E. Check settings and operation of pressure-reducing valves. Record final settings.
- F. Check settings and operation of each safety valve. Record settings.

3.07 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

- A. Balance system with manual or automatic balancing valves by setting at design flow.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- B. Adjust pump to deliver total design flow.
 - 1. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - 2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
 - 3. Mark final settings and verify that all memory stops have been set.
 - 4. Verify final system conditions as follows:
 - a. Re-measure and confirm that total flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.

3.08 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.

3.09 PROCEDURES FOR WATER HEATERS

- A. Electric Water Heaters:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Measure and record pressure drop.
 - 4. Measure and Record relief valve(s) pressure setting.
 - 5. Capacity: Calculate in Btu/h of heating output.
 - 6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the condition of filters.
 - 4. Check bearings and other lubricated parts for proper lubrication.
 - 5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
 - 1. New filters are installed.
 - 2. Bearings and other parts are properly lubricated.
 - 3. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated system flows of the renovated work to the measured flows, and determine the new pump speed.
 - 2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the system flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

3.11 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:
 1. Domestic Water Flow Rate: Plus 10 percent or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
 2. Compressed-Air Flow Rate: Plus 10 percent or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

3.12 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 1. Pump curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.

6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 14. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
1. Flow rates.
 2. Pipe and valve sizes and locations.
 3. Balancing stations.
 4. Position of balancing devices.
- E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Model number and unit size.
 - d. Manufacturer's serial number.
 - e. Output capacity in Btu/h.
 - f. Number of stages.
 - g. Connected volts, phase, and hertz.
 - h. Rated amperage.
 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. High-temperature-limit setting in deg F.
 - e. Operating set point in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water-pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump speed.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

PART 4 - MEASUREMENT AND PAYMENT

- A. Testing, Adjusting, and Balancing for Plumbing as specified herein shall be included in the measurement and payment for "Plumbing".

- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.
 - 4. Supplies and drains for handicap-accessible lavatories and sinks.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated.

1.03 DEFINITIONS

- A. ASJ: All service jacket
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing and Materials
- D. CFC: Chlorofluorocarbons
- E. FSK: Foil-skrim kraft
- F. HCFC: Hydrochlorofluorocarbons
- G. ICC: International Code Council

- H. PVC: Polyvinyl chloride

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material test reports.
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.06 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.02 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
 - 1. Preformed Pipe Insulation: Type II, Class 1, unfaced.
 - 2. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ jacket.
 - 3. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
 - 4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.
- H. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
 - 1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
 - 2. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
 - 3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral Wool, Preformed Pipe: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C547.
 - 1. Preformed Pipe Insulation: Type II, Grade A with factory-applied ASJ.
 - 2. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
- J. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

- C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
 - 1. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 - 2. Wet Flash Point: Below 0 deg F.
 - 3. Service Temperature Range: 40 to 200 deg F.
 - 4. Color: Black.
- D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.05 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Permanently flexible, elastomeric sealant.
 - 2. Service Temperature Range: Minus 58 to plus 176 deg F.
 - 3. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 - 1. Fire- and water-resistant, flexible, elastomeric sealant.
 - 2. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 3. Color: Aluminum.
- D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 1. Fire- and water-resistant, flexible, elastomeric sealant.

2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

2.06 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
 5. PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.

- 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.
- F. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.
1. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
 2. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
 3. Aluminum Finish: Embossed.

2.08 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
- B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Wing seals are primarily used for fastening bands together. Closed seals are occasionally used for large, 84-inch- (2130-mm-) diameter applications and where fastening bands are used with springs. Wing seals are reusable; closed seals are not.
 - 2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
 - 3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
 - 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the contract documents.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install

- insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING."

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit.

- Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive, or via self-seal mechanism to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 INSTALLATION OF FIELD-APPLIED JACKETS

3.10 FIELD-APPLIED JACKETS

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "EXTERIOR PAINTING" and Section 09 91 23 "INTERIOR PAINTING."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by the Engineer. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.12 FIELD QUALITY CONTROL

A. The City will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by the Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three

locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- D. All insulation applications will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.13 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. Insulation shall be one of the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1-1/2 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1-1/2 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
 - b. Mineral Wool, Preformed Pipe Insulation, Type II: 2-1/2 inch thick.
- C. Domestic Chilled Water (Potable):
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - c. Mineral Wool, Preformed Pipe Insulation, Type II: 1-1/2 inch thick.
- D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - c. Mineral Wool, Preformed Pipe Insulation, Type II: 1/2 inch thick.
 - d. Polyolefin: 3/4 inch thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
 - c. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inches thick.
 - c. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
 - d. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None.
- D. Piping, Exposed:
 1. PVC: 20 mils thick.

PART 4 - MEASUREMENT AND PAYMENT

- A. Plumbing Piping Insulation as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings - domestic water.
 - 2. Galvanized-steel pipe and fittings - domestic water.
 - 3. Piping joining materials - domestic water.
 - 4. Transition fittings - domestic water.
 - 5. Dielectric fittings - domestic water.

1.02 ACTION SUBMITTALS

- A. Product data.

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. ASSE: American Society of Sanitary Engineering
- D. AWWA: American Water Works Association
- E. BIM: Building information modeling
- F. CPVC: Chlorinated polyvinyl chloride
- G. EPDM: Ethylene propylene diene monomer
- H. IAPMO: International Association of Plumbing and Mechanical Officials
- I. MSS: Manufacturers Standardization Society
- J. PVC: Polyvinyl chloride
- K. NPS: Nominal pipe size
- L. NSF: National Sanitation Foundation

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.02 PIPING MATERIALS

- A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372.

2.03 COPPER TUBE AND FITTINGS - DOMESTIC WATER

- A. Drawn-Temper Copper Tube: ASTM B88, Type K ASTM B88, Type L and ASTM B88 Type M.
- B. Annealed-Temper Copper Tube: ASTM B88, Type K.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.
- F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.

- G. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.
- H. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:
 - 1. Housing: Copper.
 - 2. O-Rings and Pipe Stops: EPDM.
 - 3. Tools: Manufacturer's special tools.
 - 4. Minimum 200 psig working-pressure rating at 250 deg F.

2.04 STAINLESS STEEL PIPE AND FITTINGS - DOMESTIC WATER

- A. Schedule 40S Type 316L for use with grooved mechanical couplings with rolled grooved ends and Type 316L components as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends shall be grooved in accordance with standards conforming to ANSI/AWWA C606.
- B. Stainless steel fittings shall be of the same alloy as the pipe described above.
- C. Refer to current manufacturer's literature for pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules.
- D. Stainless Steel Fittings: Fittings shall be smooth turn full flow stainless steel fittings with grooves designed to accept grooved end couplings. Provide Schedule 40S fittings. Mitered fittings are not allowed, except for angles 7-1/2 degrees or less. Otherwise, when a directional change requires a non-standard, single-plane angle the required angle shall be achieved by trimming a standard 45° or 90° elbow. Fittings shall be factory passivated.

2.05 TRANSITION FITTINGS - DOMESTIC WATER

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.
- D. Plastic-to-Metal Transition Fittings - Domestic Water:
 - 1. Description:
 - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket end.
- E. Plastic-to-Metal Transition Unions - Domestic Water:
 - 1. Description:

- a. CPVC or PVC four-part union.
- b. Brass or stainless steel threaded end.
- c. Solvent-cement-joint plastic end.
- d. Rubber O-ring.
- e. Union nut.

2.06 DIELECTRIC FITTINGS - DOMESTIC WATER

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions - Domestic Water:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig minimum at 180 deg F.
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges - Domestic Water:
 - 1. Standard: ASSE 1079.
 - 2. Factory-fabricated, bolted, companion-flange assembly.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits - Domestic Water:
 - 1. Nonconducting materials for field assembly of companion flanges.
 - 2. Pressure Rating: 150 psig.
 - 3. Gasket: Neoprene or Phenolic.
 - 4. Bolt Sleeves: Phenolic or polyethylene.
 - 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples - Domestic Water:
 - 1. Standard: IAPMO PS 66.
 - 2. Electroplated steel nipple complying with ASTM F1545.
 - 3. Pressure Rating and Temperature: 300 psig at 225 deg F.
 - 4. End Connections: Male threaded or grooved.
 - 5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

- D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller is to be the following:
 - 1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water and non-potable piping, NPS 2 (DN 50) and smaller is to be the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type L or ASTM B88, Type M; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 - 2. Drawn-temper copper tube, ASTM B88, Type L or ASTM B88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
- F. Aboveground high pressure non-potable water piping, NPS 2 (DN 50) and smaller is to be the following:
 - 1. Stainless steel pipe, Schedule 40S Type 316L; roll grooved fittings and joints.

3.02 EARTHWORK

- A. Comply with requirements in Section 31 00 00 "EARTHWORK" for excavating, trenching, and backfilling.

3.03 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install valves in accordance with the following:
 - 1. Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."
 - 2. Section 22 05 23.14 "CHECK VALVES FOR PLUMBING PIPING."
- C. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- G. Install piping to permit valve servicing.
- H. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- L. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23.21 "INLINE, DOMESTIC WATER PUMPS."
- M. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "METERS AND GAGES FOR PLUMBING PIPING."
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING."
- O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING."
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."
- Q. Stainless steel piping shall not come into contact with ferrous material during its handling, storage, staging, transporting, or fabrication.
- R. The fabrication of stainless steel shall be segregated from that of ferrous materials.
- S. Fabricating tools that come in contact with stainless steel shall be dedicated to stainless steel.

3.04 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- H. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- I. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End Steel Piping: Make joints in accordance with AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Stainless Steel Grooved Tubing System
 - 1. Verify gasket style and elastomeric material (grade) is suitable for the intended service as specified and in combination with any system chemical additives.
 - 2. Reference latest published manufacturer's product data for additional pressure ratings and application information.
 - 3. Reference latest published manufacturer's field installation instructions or other included installation instruction prior to attempting assembly.
 - 4. Ream, debur and clean tube ends and verify they are free from indentations, projections and roll marks in the area from tube end to groove for proper gasket sealing.
 - 5. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) and all grooving tools shall be of one manufacturer.
 - 6. Install gaskets with lubricant suitable for system piping services. Lubricant shall be by one manufacturer.
 - 7. Keep ductile couplings for hi-rise applications where pressures exceeds 200 psi. Verify pressure rating of couplings and schedule of stainless steel specified above.
 - 8. Keep stainless steel couplings for hi-rise applications where pressures exceeds 200 psi. Verify pressure rating of couplings and schedule of stainless steel specified above.
 - 9. Provide stainless steel couplings.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.
- M. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.05 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.

- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.06 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.07 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT."
- B. Install hangers for copper, galvanized steel and stainless steel tube and pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper, galvanized steel and stainless steel tube and pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.08 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.09 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system in accordance with either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.
 - f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - g. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 4 - MEASUREMENT AND PAYMENT

- A. Domestic Water Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Balancing valves.
 - 4. Temperature-actuated, water mixing valves.
 - 5. Strainers for domestic water piping.
 - 6. Hose bibbs.
 - 7. Drain valves.
 - 8. Water-hammer arresters.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C.ASSE: American Society of Sanitary Engineers
- D. AWWA: American Water Works Association
- E. CWP: Cold working pressure
- F. MSS: Manufacturers Standardization Society
- G. NPS: Nominal pipe size
- H. NSF: National Sanitation Foundation
- I. PDI: Plumbing & Drainage Institute

1.04 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Standard: ASSE 1001.
 - 2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 3. Body: Bronze.
 - 4. Inlet and Outlet Connections: Threaded.
 - 5. Finish: Rough bronze or Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 - 1. Standard: ASSE 1011.
 - 2. Body: Bronze, nonremovable, with manual drain.
 - 3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 4. Finish: Chrome or nickel plated.

2.04 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:
 - 1. Standard: ASSE 1012.
 - 2. Operation: Continuous-pressure applications.
 - 3. Size: As indicated on drawings.

4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Rough bronze.

B. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Size, flow rate, and pressure loss: as indicated on drawings.
4. Body: Bronze for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.05 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass or stainless steel.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.06 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Standard: ASSE 1070.
2. Pressure Rating: 125 psig.
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded or union inlets and outlet.
6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Tempered-Water Setting: as indicated on drawings..
8. Tempered-Water Design Flow Rate: as indicated on drawings.
9. Valve Finish: Chrome plated or Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Type: Exposed-mounted, thermostatically controlled, water mixing valve.

4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Tempered Setting, flow rate, and pressure loss: as indicated on drawings.
8. Valve Finish: Chrome plated.
9. Piping Finish: Chrome plated.

2.07 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Pipe plug or Factory-installed, hose-end drain valve.

2.08 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.09 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.

4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.
- C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- D. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- E. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- F. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

3.02 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.03 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
- B. Ground equipment in accordance with Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.04 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated, water mixing valves.
 - 6. Wall hydrants.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.05 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
- D. Adjust each pressure vacuum breaker and double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections.
 - 1. Test each pressure vacuum breaker and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 4 - MEASUREMENT AND PAYMENT

- A. Domestic Water Piping Specialties as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 11 23.21

INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 DEFINITIONS

- A. NEMA: National Electrical Manufacturers Association
- B. NFPA: National Fire Protection Association
- C. NPS: Nominal pipe size
- D. NSF: National Sanitation Foundation
- E. UL: Underwriters Laboratories

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail pumps and adjacent equipment, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.02 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.
- B. Capacities and Characteristics: as shown on drawings.
- C. Pump Construction:
 - 1. Casing:
 - a. Radially split bronze with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 - b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
 - c. Gauge port tapings at suction and discharge nozzles.
 - 2. Impeller: Bronze or brass, statically and dynamically balanced, closed, and keyed to shaft.
 - 3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
 - 4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
 - 5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
 - 6. Bearings: Grease-lubricated or permanently lubricated ball type.
 - 7. Minimum Working Pressure: 175 psig.
 - 8. Continuous Operating Temperature: 225 deg F.
- D. Motor: Single speed, with grease-lubricated ball bearings; resiliently or rigidly mounted to pump casing.

2.03 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT."
 - 1. Motor Sizes: Minimum size as indicated in the Drawings. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.04 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - 1. Type: Water-immersion temperature sensor, for installation in piping.

2. Range: 65 to 200 deg F.
3. Enclosure: NEMA 250.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V ac or 120 V ac.
7. Settings: Start pump at 120 deg F and stop pump at 130 deg F.

B. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 24 V ac 120 V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount pumps in orientation complying with manufacturer's written instructions.
- B. Install continuous-thread hanger rods of size required to support pump weight.
 1. Comply with requirements for hangers and supports specified in Section 22 05 29 "HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT."
- C. Install thermostats in hot-water return piping.
- D. Install timers nearby pump, on wall.
- E. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT" for identification of pumps.
- F. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Check piping connections for tightness.
 3. Clean strainers on suction piping.
 4. Set thermostats and timers for automatic starting and stopping operation of pumps.
 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 7. Start motor.
 8. Open discharge valve slowly.
 9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.02 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "DOMESTIC WATER PIPING." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
 - b. Comply with requirements for flexible connectors specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 22 11 19 "DOMESTIC WATER PIPING SPECIALTIES." Comply with requirements for valves specified in the following:
 1. Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."
 2. Section 22 05 23.14 "CHECK VALVES FOR PLUMBING PIPING."
 3. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tapings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 22 05 19 "METERS AND GAGES FOR PLUMBING PIPING."

3.03 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: City will engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

- 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

PART 4 - MEASUREMENT AND PAYMENT

- A. Inline, Domestic-Water Pumps as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 13 13
FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. PVC pipe and fittings.
 - 2. Nonpressure-type transition couplings.
 - 3. Cleanouts.
 - 4. Encasement for piping.
 - 5. Concrete.

1.02 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.03 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe and fittings.
 - 2. Non-pressure and pressure couplings
 - 3. Cleanouts.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
 - 2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- B. Product Certificates: For each type of pipe and fitting.
- C. Field quality-control reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.06 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by the City or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify the City no fewer than Seven days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without the City's written permission.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

- A. PVC Type PSM Sewer Piping:
 - 1. Pipe: ASTM D3034, SDR 35 PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D3034, PVC with bell ends.
 - 3. Gaskets: ASTM F477, elastomeric seals.
 - 4. Cell Classification: Pipe shall be made of PVC plastic having a cell classification of 12454 or 13364, as defined in ASTM D1784.

2.02 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - 2. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
 - 1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Shielded, Flexible Couplings:
 - 1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.03 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

2.04 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 00 00 "EARTHWORK."

3.02 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of **2** percent unless otherwise indicated.
 - 2. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.03 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
 - 2. Join dissimilar pipe materials with nonpressure-type, flexible **or rigid** couplings.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - 1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. **Shielded** flexible **or rigid** couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible **or rigid** couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.04 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.05 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

- B. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.06 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.07 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.08 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.09 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

PART 4 - MEASUREMENT AND PAYMENT

- A. Facility Sanitary Sewers as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. PVC pipe and fittings.
 - 4. Specialty pipe fittings.

1.02 ACTION SUBMITTALS

- A. Product data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.
- B. Field quality-control reports.

1.04 DEFINITIONS

- A. CISPI: Cast Iron Soil Pipe Institute
- B. MSS: Manufacturers Standardization Society
- C. NPS: Nominal pipe size
- D. NSF: National Sanitation Foundation

1.05 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.

2.02 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and fittings in this article are available in NPS 2 to NPS 15 (DN 50 to DN 375).
- B. Pipe and Fittings:
 1. Marked with CISPI collective trademark.
 2. ASTM A74, service cast iron.
- C. Gaskets: ASTM C564, rubber.
- D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe in "Pipe and Fittings" Paragraph below is available in NPS 1-1/2 to NPS 15 (DN 40 to DN 375).
- B. Pipe and Fittings:
 1. Marked with CISPI collective trademark.
 2. ASTM A888 or CISPI 301.
- C. CISPI, Hubless-Piping Couplings:
 1. Standards: ASTM C1277 and CISPI 310.
 2. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- D. Heavy-Duty, Hubless-Piping Couplings:
 1. Standards: ASTM C1277 and ASTM C1540.
 2. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.05 PVC PIPE AND FITTINGS

- A. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

- C. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F656.
- E. Solvent Cement: ASTM D2564.

2.06 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
 - 3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "EARTH MOVING."

3.02 PIPING INSTALLATION

- A. Drawings, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 3. Do not change direction of flow more than 90 degrees.
 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

- M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Install aboveground PVC piping in accordance with ASTM D2665.
- O. Install underground PVC piping in accordance with ASTM D2321.
- P. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 22 13 19 "SANITARY WASTE PIPING SPECIALTIES."
 - 2. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 22 13 19 "SANITARY WASTE PIPING SPECIALTIES."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 22 05 17 "SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 22 05 17 "SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."

3.03 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

- D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- E. Joint Restraints and Sway Bracing:
 - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.04 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.

3.05 VALVE INSTALLATION

- A. General valve installation requirements for general-duty valve installation are specified in the following Sections:
 - 1. Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."
 - 2. Section 22 05 23.14 "CHECK VALVES FOR PLUMBING PIPING."

3.06 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT".
 - 1. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
 - 2. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42 clamps.
 - 4. Install individual, straight, horizontal piping runs:
 - a. 100 Ft. and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Ft. if Indicated: MSS Type 49, spring cushion rolls.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
 - 6. Base of Vertical Piping: MSS Type 52 spring hangers.

- B. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- E. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "SANITARY WASTE PIPING SPECIALTIES."
 - 6. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections in accordance with the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

- B. Comply with requirements for identification specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.09 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller are to be any of the following:
 1. Service Class cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger are to be any of the following:
 1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller is to be any of the following:
 1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger is to be any of the following:
 1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller are to be any of the following:

1. Service cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger are to be any of the following:
1. Service, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sanitary Waste and Vent Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Miscellaneous sanitary drainage piping specialties.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

1.05 DEFINITIONS

- A. ASME: American Society of Mechanical Engineers
- B. IAPMO: International Association of Plumbing and Mechanical Officials
- C. MSS: Manufacturers Standardization Society
- D. NPS: Nominal pipe size
- E. NSF: National Sanitation Foundation
- F. PVC: Polyvinyl chloride

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.02 CLEANOUTS

- A. Cast-Iron Exposed Floor Cleanouts:
 - 1. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 2. Size: Same as connected branch.
 - 3. Type and materials as scheduled on drawings.
 - 4. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

2.03 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
 - 2. Size: Same as connected waste piping with increaser fitting of size indicated.
- B. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- D. Sleeve Flashing Device:
 - 1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.
- E. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- F. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- G. Trap Seals
1. Description: Smooth, soft, flexible elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom. The flow of wastewater allows duck's bill to open and adequately discharge to floor drain through its interior. The duck's bill closes and returns to original molded shape after wastewater discharge is complete. Or, smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its interior. The flapper closes and returns to original molded shape after wastewater discharge is complete.
 2. te.
 3. Size: same as drain connection.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Assemble open drain fittings and install with top of hub 2 inches above floor.
- E. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- I. Install vent caps on each vent pipe passing through roof.
- J. Install wood-blocking reinforcement for wall-mounting-type specialties.
- K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 PIPING CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "SANITARY WASTE AND VENT PIPING" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

3.03 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
1. Nameplates and signs are specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sanitary Waste Piping Specialties as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 13 19.13

SANITARY DRAINS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Floor sinks.

1.02 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene styrene
- B. ASME: American Society of Mechanical Engineers
- C. FRP: Fiberglass-reinforced plastic
- D. HDPE: High-density polyethylene
- E. NSF: National Sanitation Foundation
- F. PE: Polyethylene
- G. PP: Polypropylene
- H. PVC: Polyvinyl chloride

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.02 FLOOR DRAINS

- A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Description: as indicated on Drawings.

2.03 FLOOR SINKS

- A. Cast-Iron Floor Sinks:
1. Standard: ASME A112.6.7.
 2. Description: as indicated on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install open drain fittings with top of hub 2 inches above floor.

3.02 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "SANITARY WASTE AND VENT PIPING" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 22 13 19 "SANITARY WASTE PIPING SPECIALTIES" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.

- D. Ground equipment according to Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
- E. Connect wiring according to Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."

3.03 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sanitary Drains as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 15 13

GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes piping and related specialties for general-service compressed-air systems, as follows:
 - 1. Pipes, tubes, and fittings.
 - 2. Joining materials.
 - 3. Valves.
 - 4. Dielectric fittings.
 - 5. Flexible pipe connectors.
 - 6. Specialties.
 - 7. Quick couplings.
 - 8. Hose assemblies.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Plastic pipes, fittings, and valves.
 - 2. Dielectric fittings.
 - 3. Flexible pipe connectors.
 - 4. Safety valves.
 - 5. Pressure regulators. Include rated capacities and operating characteristics.
 - 6. Automatic drain valves.
 - 7. Filters. Include rated capacities and operating characteristics.
 - 8. Quick couplings.
 - 9. Hose assemblies.

1.03 INFORMATIONAL SUBMITTALS

- A. Certificates:
 - 1. Brazing certificates.
- B. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 DEFINITIONS

- A. ASME: American Society of Mechanical Engineers
- B. AWS: American Welding Society
- C. MSS: Manufacturers Standardization Society
- D. NPS: Nominal pipe size

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by respective manufacturer.
- B. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or with AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. ASME Compliance:
 - 1. Comply with ASME B31.3, "Process Piping," for low-pressure, compressed-air piping.
 - 2. Comply with ASME B31.9, "Building Services Piping," for low-pressure, compressed-air piping.

2.02 PIPES, TUBES, AND FITTINGS

2.03 TINGS

- A. Copper Tube: ASTM B88, Type L seamless, drawn-temper, water tube.
 - 1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
 - 2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123.
- B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.04 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.05 VALVES

- A. Metal Ball and Check Valves: Comply with requirements in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING," and Section 22 05 23.14 "CHECK VALVES FOR PLUMBING PIPING."

2.06 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.07 FLEXIBLE PIPE CONNECTORS

- A. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: 200 psig minimum.
 2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

2.08 SPECIALTIES

- A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
 1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
- B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250 psig inlet pressure, unless otherwise indicated.
 1. Type: Pilot operated.

- C. Air-Line Pressure Regulators, Bronze Body: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.
- D. Air-Line Pressure Regulators, Aluminum Alloy or Plastic Body: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.
- E. Automatic Drain Valves: Stainless steel body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate.
- F. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.
- G. Mechanical Filters: Two-stage, mechanical-separation, air-line filters. Equip with deflector plates, resin-impregnated-ribbon filters with edge filtration, and drain cock.

2.09 QUICK COUPLINGS

- A. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- B. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless steel or nickel-plated-steel operating parts.
 - 1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug End: Flow-sensor-bleeder, check-valve type with barbed outlet for attaching hose.
- C. Valveless Quick Couplings: Straight-through brass body with stainless steel or nickel-plated-steel operating parts.
 - 1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
 - 2. Plug End: With barbed outlet for attaching hose.

2.10 HOSE ASSEMBLIES

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300 psig minimum working pressure, unless otherwise indicated.
 - 1. Hose: Reinforced single- or double-wire-braid, CR-covered hose for compressed-air service.
 - 2. Hose Clamps: Stainless steel clamps or bands.
 - 3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
 - 4. Hose Splicers: One-piece, straight-through brass or stainless steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use the following piping materials:
 - 1. NPS 2 and Smaller: Type K or L copper tube; wrought-copper fittings; and brazed or soldered joints.

3.02 VALVE APPLICATIONS

- A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Article in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING," according to the following:
 - 1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
 - 2. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.03 INSTALLATION OF PIPING, GENERAL

- A. Drawings, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
- E. Where installing piping adjacent to equipment and machines, allow space for service and maintenance.
- F. Install air and drain piping with 1 percent slope downward in direction of flow.
- G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.
- H. Equipment and Specialty Flanged Connections:
 - 1. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

- I. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, in accordance with Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.
- J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- L. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- M. Install piping to permit valve servicing.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."

3.04 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Brazed Joints for Copper Tubing: Join in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- E. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

- F. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.05 INSTALLATION OF VALVES

- A. General-Duty Valves: Comply with requirements in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."

3.06 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. NPS 2 and Smaller: Use dielectric unions.

3.07 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

- A. Install flexible pipe connectors in discharge piping of each air compressor.
- B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

3.08 INSTALLATION OF SPECIALTIES

- A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
- B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
- C. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.
- D. Install quick couplings at piping terminals for hose connections.
- E. Install hose assemblies at hose connections.
- F. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.09 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 22 05 29 "HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT" for hangers, supports, and anchor devices.
- B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for aluminum piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting and coupling.

- E. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of aluminum piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Ft. or Less: MSS Type 1, adjustable, steel clevis hangers.
 - 2. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
- H. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- I. Base of Vertical Piping: MSS Type 52, spring hangers.

3.10 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.11 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 2. Piping Leak Tests for Aluminum Compressed-Air Piping: Test new piping system and modified parts of existing piping system. Cap and fill general-service compressed-air piping system to pressure of 15 psig, hold pressure for 10 minutes. Repeat until reaching required operating pressure, not to exceed 220 psig. Once desired operating pressure is met, let stand for one hour.
 - 3. Repair leaks and retest until no leaks exist.
 - 4. Inspect filters and pressure regulators for proper operation.
- C. Prepare test and inspection reports.

PART 4 - MEASUREMENT AND PAYMENT

- A. General-Service Compressed-Air Piping as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 33 00

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of commercial, electric, domestic-water heater.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

- B. ASME: American Society of Mechanical Engineers
- C. ANSI: American National Standards Institute
- D. ASSE: American Society of Sanitary Engineers
- E. NFPA: National Fire Protection Association
- F. NTRL: National Technical Reports Library
- G. NSF: National Sanitation Foundation
- H. PDI: Plumbing and Drainage Institute
- I. UL: Underwriters Laboratories

1.06 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.07 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Two years.
 - b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.02 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:

1. Standard: UL 174.
2. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
3. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - d. Insulation: Comply with ASHRAE/IES 90.1.
 - e. Jacket: Steel with enameled finish or high-impact composite material.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Electric, screw-in immersion type.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
4. Special Requirements: NSF 5 construction with legs for off-floor installation.

B. Capacity and Characteristics: as scheduled on the drawings.

2.03 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
3. Capacity and Characteristics: as scheduled on the drawings.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

- C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.
- D. Heat-Trap Fittings: ASHRAE/IES 90.1.
- E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.
- F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
- G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
- H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 03 30 00 "CAST-IN-PLACE CONCRETE."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."

- C. Install commercial, electric, domestic-water heaters with restraint straps. Comply with requirements for seismic-restraint devices specified in the California Plumbing Code.
- D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "DOMESTIC WATER PIPING SPECIALTIES."
- F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "METERS AND GAGES FOR PLUMBING PIPING."
- G. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill electric, domestic-water heaters with water.
- I. Charge domestic-water expansion tanks with air to required system pressure.
- J. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.
- K. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.02 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "DOMESTIC WATER PIPING." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.04 DEMONSTRATION

- A. Train City's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training to be a minimum of one hour(s).

PART 4 - MEASUREMENT AND PAYMENT

- A. Electric, Domestic-Water Heaters as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 42 13.13
COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Floor-mounted, bottom-outlet water closets.
 - 2. Wall-mounted water closets.
 - 3. Flushometer valves.
 - 4. Toilet seats.
 - 5. Supports.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power and control wiring.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.04 DEFINITIONS

- A. ASME: American Society of Mechanical Engineers
- B. ANSI: American National Standards Institute
- C.ASSE: American Society of Sanitary Engineers
- D. IAPMO: International Association of Plumbing and Mechanical Officials
- E. ICC: International Code Council
- F. NPS: Nominal Pipe Size

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Standards:
 - 1. Comply with ASME A112.19.2/CSA B45.1 for water closets.

2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. Comply with ASME A112.6.1M for water-closet supports.
6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.02 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets - Floor Mounted, Bottom Outlet, Top Spud: .

1. Bowl:
 - a. Material: Vitreous china.
 - b. Type: Siphon jet.
 - c. Style: Flushometer valve.
 - d. Height: ADA compliant.
 - e. Rim Contour: Elongated.
 - f. Water Consumption: 1.28 gal. per flush.
 - g. Spud Size and Location: NPS 1-1/2; top.
 - h. Color: White.

2.03 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Lever Handle:

1. Minimum Pressure Rating: 125 psig.
2. Features: Include integral check stop and backflow-prevention device.
3. Material: Brass body with corrosion-resistant components.
4. Style: Exposed.
5. Flushometer-Valve Finish: Chrome-plated.
6. Handle Finish: Chrome-plated Antimicrobial.
7. Consumption: 1.28 gal. per flush.
8. Minimum Inlet: NPS 1.
9. Minimum Outlet: NPS 1-1/4.

2.04 TOILET SEATS

A. Toilet Seats:

1. Material: Plastic.
2. Type: Commercial (Heavy duty).
3. Shape: Elongated rim, open front.
4. Hinge: Check.
5. Hinge Material: Noncorroding metal.
6. Seat Cover: Not required.
7. Color: White.
8. Surface Treatment: Antimicrobial.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Water-Closet Installation:
 - 1. Install level and plumb.
 - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
- B. Flushometer-Valve Installation:
 - 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 - 4. Install actuators in locations easily reachable for people with disabilities.
- C. Install toilet seats on water closets.
- D. Wall Flange and Escutcheon Installation:
 - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 - 3. Comply with escutcheon requirements specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."
- E. Joint Sealing:
 - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to water-closet color.
 - 3. Comply with sealant requirements specified in Section 07 92 00 "JOINT SEALANTS."

3.03 PIPING CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 11 16 "DOMESTIC WATER PIPING."

- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.04 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Commercial Water Closets as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 42 16.13
COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Vitreous-china, wall-mounted lavatories.
 - 2. Manually operated lavatory faucets.
 - 3. Supply fittings.
 - 4. Waste fittings.
 - 5. Lavatory supports.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals
- C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 DEFINITIONS

- A. ASME: American Society of Mechanical Engineers
- B. ANSI: American National Standards Institute
- C. ICC: International Code Council
- D. NPS: Nominal Pipe Size

PART 2 - PRODUCTS

2.01 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory – Ledge Back, Rectangular, Vitreous China, Wall Mounted, with Back:
HD-S3195

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Commercial Lavatories
Div. 22, Section 22 42 16.13

1. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Rectangular, 20 by 18 inches.
 - d. Faucet-Hole Punching: Three holes, 4-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
2. Faucet: See "Manually Operated Lavatory Faucets" article, herein.
3. Support: - Type II, concealed-arm lavatory carrier.
4. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.1.

2.02 MANUALLY OPERATED LAVATORY FAUCETS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Lavatory Faucets - Manual Type: Two-handle mixing, commercial.
 1. Standard: ASME A112.18.1/CSA B125.1.
 2. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 3. Body Type: Centerset.
 4. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 5. Finish: Polished chrome plate.
 6. Maximum Flow Rate: 0.5 gpm.
 7. Mounting Type: Deck, exposed.
 8. Valve Handle(s): Lever handles, 2 inch.
 9. Spout: Rigid type.
 10. Spout Outlet: Aerator.
 11. Operation: Noncompression, manual.

2.03 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.

F. Risers:

1. NPS 3/8.
2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.04 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material:
 - a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.
 - b. Stainless steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless steel tube to wall; and stainless steel wall flange.

2.05 LAVATORY SUPPORTS

A. Lavatory Carrier:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install lavatories level and plumb in accordance with manufacturer's requirements.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "JOINT SEALANTS."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "PLUMBING PIPING INSULATION."

3.02 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."

3.03 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

3.04 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by the City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Commercial Lavatories as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 42 16.16

COMMERCIAL SINKS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Service sinks.
 - 2. Manually operated sink faucets.
 - 3. Supply fittings.
 - 4. Waste fittings.
 - 5. Sink supports.
 - 6. Grout.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.04 DEFINITIONS

- A. ASME: American Society of Mechanical Engineers
- B. ANSI: American National Standards Institute
- C.ASSE: American Society of Sanitary Engineers
- D. ICC: International Code Council
- E. NPS: Nominal Pipe Size

PART 2 - PRODUCTS

2.01 SERVICE SINKS

- A. Service Sinks - Enameled Cast Iron, Trap Standard Mounted: .
 - 1. Fixture:
 - a. Standard: ASME A112.19.1/CSA B45.2.
 - b. Type: Service sink with back.

- c. Back: Two faucet holes.
- d. Nominal Size: 24 by 20 inches.
- e. Color: White.
- f. Mounting: NPS 3 P-trap standard with grid strainer inlet, cleanout, and floor flange.
- g. Rim Guard: On front and sides.

2. Faucet: See "Manually Operated Sink Faucets" Article.

2.02 MANUALLY OPERATED SINK FAUCETS

- A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Commercial Service Sink Faucets - Manual Type:
 - 1. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
 - 2. Faucet:
 - a. Standards:
 - 1) ASME A112.18.1/CSA B125.1.
 - 2) NSF 61 and NSF 372.
 - 3) ICC A117.1.
 - 4) ASSE 1001 (VB).
 - b. Finish: Polished chrome plated.
 - c. Handles: Lever.
 - d. Cartridges: One-fourth turn compression Ceramic.
 - e. Brace: Adjustable top brace.

2.03 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:

1. NPS 3/8.
2. Chrome-plated, rigid-copper pipe.

2.04 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
 1. Size: NPS 1-1/2.
 2. Material:
 - a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.05 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install sinks level and plumb in accordance with manufacturer's requirements.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."
 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."

- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "JOINT SEALANTS."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "PLUMBING PIPING INSULATION."

3.02 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."

3.03 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

3.04 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Commercial Sinks as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Eye/face wash equipment.
 - 2. Water-tempering equipment.

1.02 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.
- D. Tepid: Between 60 and 100 deg F.
- E. ASME: American Society of Mechanical Engineers
- F. ANSI: American National Standards Institute
- G. ASSE: American Society of Sanitary Engineers
- H. ICC: International Code Council
- I. NFPA: National Fire Protection Association
- J. NPS: Nominal Pipe Size

1.03 ACTION SUBMITTALS

- A. Product data: For each type of product.
- B. Shop Drawings:
 - 1. Plans, elevations, sections, and mounting details.
 - 2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Submittals:
 - 1. Field quality-control reports.
- B. Emergency fixture third-party certification documentation.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.
- B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.
- C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.
- D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
- E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.
- F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 EYE/FACE WASH EQUIPMENT

- A. Eye/Face Wash Units - Wall Mounted, Fixed Type, Plumbed:
 - 1. Capacity: Not less than 3 gpm for at least 15 minutes.
 - 2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - 3. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
 - 4. Spray-Head Assembly: Two or four spray heads with offset piping.
 - 5. Receptor: Stainless steel or plastic bowl.
 - 6. Mounting: Wall mounted.

2.03 WATER-TEMPERING EQUIPMENT

- A. Water-Tempering Equipment - Hot and Cold Water: .
 - 1. Description: Factory-fabricated equipment with thermostatic mixing valve.

- a. Thermostatic Mixing Valve: Designed to provide 80 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
- b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.01 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING."
 - 1. Exceptions:
 - a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - b. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 22 05 19 "METERS AND GAGES FOR PLUMBING PIPING."
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."
- J. Fill self-contained fixtures with flushing fluid.

3.02 PIPING CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."
- E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- F. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.03 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT."

3.04 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.
- B. Adjust or replace fixture flow regulators for proper flow.
- C. Adjust equipment temperature settings.

3.06 CLEANING AND PROTECTION

- A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed emergency plumbing fixtures and fittings.
- C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Emergency Plumbing Fixtures as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 22 47 16

PRESSURE WATER COOLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pressure water coolers.
 - 2. Bottle filling stations.
 - 3. Supports.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler and bottle filling station.
- B. Shop Drawings:
 - 1. Include diagrams for power wiring.

1.03 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Standards:
 - 1. Pressure water coolers and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
 - 2. Comply with ASHRAE 34 for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
 - 3. Comply with UL 399.
 - 4. Comply with ASME A112.19.3/CSA B45.4.
 - 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 6. Comply with NSF 42 and NSF 53 for water filters for water coolers and bottle filling stations.
 - 7. Comply with ICC A117.1 for accessible water coolers and bottle filling stations.

2.02 PRESSURE WATER COOLERS

A. Pressure Water Coolers - Surface Wall-Mounted, Stainless Steel.

1. Type: Vandal resistant.
2. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
3. Control: Push bar.
4. Bottle Filler: Sensor activation.
5. Drain: Grid with NPS 1-1/4 tailpiece.
6. Supply: NPS 3/8 with shutoff valve.
7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
8. Filter: One or more water filters with capacity sized for unit peak flow rate.
9. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
10. Support: Water-cooler carrier.
11. Water-Cooler Mounting Height: High/low - standard/accessible in accordance with ICC A117.1. Provide with Cane Apron on high side.
12. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Volts: 120 V ac.
 - 2) Phase: Single.
 - 3) Hertz: 60 Hz.
 - 4) Full-Load Amperes: 1 A.

2.03 SUPPORTS

A. Water-Cooler Carrier:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and bottle filling stations to mounting frames.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping".

- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "ESCUTCHEONS FOR PLUMBING PIPING."
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "JOINT SEALANTS."

3.02 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "DOMESTIC WATER PIPING."
- C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 22 05 23.12 "BALL VALVES FOR PLUMBING PIPING"
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "SANITARY WASTE AND VENT PIPING."

3.03 ELECTRICAL CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
 - 2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.04 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.05 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by the City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Pressure Water Coolers as specified herein shall be included in the measurement and payment for "Plumbing".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

1.03 DEFINITIONS

- A. NEMA: National Electrical Manufacturers Association
- B. IEEE: Institute of Electrical and Electronics Engineers

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 100 deg F and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

- A. Equipment as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves without waterstop.
 - 2. Sleeves with waterstop.
 - 3. Stack-sleeve fittings.
 - 4. Sleeve-seal systems.
 - 5. Grout.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 DEFINITIONS

- A. ASTM: American Society for Testing and Materials
- B. EPDM: Ethylene propylene diene monomer
- C. ID: Inner diameter

PART 2 - PRODUCTS

2.01 SLEEVES WITHOUT WATERSTOP

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends.
- C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.02 SLEEVES WITH WATERSTOP

- A. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

2.03 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Designed to form a hydrostatic seal of 20 psig.
 - 2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.

- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
- 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "PENETRATION FIRESTOPPING."

3.02 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal space around outside of sleeves.

3.03 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - 2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.05 SLEEVE SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops or stack-sleeve fittings.
 - 4. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sleeves and Sleeve Seals for HVAC Piping as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 18
ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.02 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. ID: Inner diameter
- C. OD: Outer diameter

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel cast brass or split-plate steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
 - e. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
 - f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - h. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
 - j. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

3.02 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

PART 4 - MEASUREMENT AND PAYMENT

- A. Escutcheons for HVAC Piping as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Fastener systems.
 - 4. Equipment stands.
 - 5. Equipment supports.

1.02 DEFINITIONS

- A. ASCE: American Society of Civil Engineers
- B. ASME: American Society of Mechanical Engineers
- C. AWS: American Welding Society
- D. IAPMO: International Association of Plumbing and Mechanical Officials
- E. MSS: Manufacturers Standardization Society
- F. NPS: Nominal pipe size
- G. OD: Outer diameter

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Stainless Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- B. Copper Pipe and Tube Hangers:
 1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: stainless steel.
 - 2. Outdoor Applications: Stainless steel.

2.06 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MATERIALS

- A. Aluminum: ASTM B221.
- B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- C. Stainless Steel: ASTM A240/A240M.
- D. Threaded Rods: Continuously threaded. Stainless steel for indoor and outdoor applications. Mating nuts and washers of similar materials as rods.

- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.

- c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

- B. Touchup: Comply with requirements in Section 09 91 13 "EXTERIOR PAINTING" and Section 09 91 23 "INTERIOR PAINTING" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use stainless steel pipe hangers and stainless steel attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 13. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 14. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
 15. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
 16. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

PART 4 - MEASUREMENT AND PAYMENT

- A. Hangers and Supports for HVAC Piping and Equipment as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 46
COATINGS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:
 - 1. Bake-cured corrosion-resistant coating systems.
 - 2. Air-dried corrosion-resistant coating systems.

1.02 DEFINITIONS

- A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.
- B. ASTM: American Society for Testing and Materials
- C. HVAC: Heating, ventilation, and air conditioning
- D. ISO: International Standards Organization
- E. UV: Ultraviolet

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include Safety Data Sheets, preparation requirements, and application instructions.

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Coatings: 1 container or spray can of each material and color applied, including base coat and top coat products.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in clean, dry, well-ventilated areas with ambient temperatures continuously maintained between 50 and 75 deg F.
 - 1. Keep containers out of direct sunlight; avoid excessive heat and keep from freezing.
 - 2. Maintain containers in clean condition, free of foreign materials and residue.
 - 3. Remove rags and waste from storage areas daily.

1.06 CONDITIONS FOR COATING APPLICATION

- A. Comply with manufacturer's recommendations regarding required temperature and humidity ranges during coating application.

PART 2 - PRODUCTS

2.01 CORROSION-RESISTANT COATING SYSTEMS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with substrate base material and with substrate-coating products applied as earlier coats.
 - 3. Products shall be of same manufacturer for each coat in a coating system.

2.02 BAKE-CURED CORROSION-RESISTANT COATING SYSTEMS

- A. Base Coat Performance Requirements:
 - 1. Corrosion Resistance: ASTM B117: 1500 hours.
 - 2. Cross-Hatch Adhesion: ASTM D3359: 5B.
 - 3. SWAAT: ASTM G85: 1000 hours.
 - 4. Cyclic Weathering: ISO 12944-9, 4200 hours.
 - 5. Mandrel Flexibility: ASTM D522/D522M: 1/4 inch without cracking or delamination of film after full cure.
 - 6. Adhesion - Elcometer: ASTM D4541: 1100 psi.
 - 7. Impact: ASTM D2794.
 - a. Direct Hit: 70 lb.-in.
 - b. Reverse Hit: 20 lb.-in.
 - 8. pH Range, 14-Day Liquid Spot Test: 2.4 to 12.6.
 - 9. Dry Heat Resistance: ASTM D2485: 320 deg F maximum.
 - 10. Dry Film Thickness: 0.5 to 1.2 mils.
 - 11. Heat-Transfer Reduction: 1 percent maximum.
 - 12. Hardness: ASTM D3363 Pencil Test: 2B-HB or 5H-6H.
- B. Bake-Cured Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.
- C. Bake-Cured, Immersion-Applied Phenolic Epoxy System.
- D. Baked-Cured, Immersion-Applied Epoxy Coating System.

2.03 AIR-DRIED CORROSION-RESISTANT COATING SYSTEMS

A. Performance Requirements:

1. Corrosion Resistance: ASTM B117: 1500 hours.
2. Cross-Hatch Adhesion: ASTM D3359: 5B.
3. Cyclic Weathering: ISO 12944-9, Offshore Standard: 4200 hours.
4. Mandrel Flexibility: ASTM D522/D522M: 1/8 inch Insert value without cracking or delamination of film after full cure.
5. Impact: ASTM D2794.
 - a. Direct Hit: 100 in-lb.
6. Dry Heat Resistance: ASTM D2485: 356 deg F maximum.
7. Dry Film Thickness: 2 to 3 mils.
8. Heat-Transfer Reduction: 1 percent maximum.
9. Hardness: ASTM D3363 Pencil Test: 2B-HB.

B. Air-Dried, Spray-Applied Principle Coating System.

C. Air-Dried Phenolic System.

D. Air-Dried, Spray-Applied Coating System.

E. Air-Dried, Spray-Applied, Polyurethane Mixed with Aluminum Flakes System.

F. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: 1500 hours.
2. SWAAT: ASTM G85: 1000 hours.
3. Cyclic Weathering: ISO 12944-9: 4200 hours.
4. Cross-Hatch Adhesion: ASTM D3359: 5B.
5. Mandrel Flexibility: ASTM D522/D522M: 1/8 inch without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: 1,100 psi
7. Impact: ASTM D2794.
 - a. Direct Hit: 100 lb.-in..
8. Dry Heat Resistance: ASTM D2485: 250 deg F maximum.
9. Dry Film Thickness: 0.5 to 1.2 mils.
10. Heat-Transfer Reduction: 1 percent maximum.
11. Hardness: ASTM D3363 Pencil Test: 2B-HB.

G. Air-Dried Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

H. Spray-Can Application Systems:

1. Type: Air dry, phenolic.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with coating manufacturer's requirements and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
 - 1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.
- B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.03 APPLICATION

- A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.
- B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.
 - 1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
 - 2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.
- C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

PART 4 - MEASUREMENT AND PAYMENT

- A. Coatings for HVAC as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 48.13

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Spring hangers.
 - 2. Restraint accessories.

1.02 DEFINITIONS

- A. ASCE: American Society of Civil Engineers
- B. ASTM: American Society for Testing and Materials
- C. HVAC: Heating, ventilation, and air conditioning
- D. NRTL: Nationally Recognized Testing Laboratory
- E. OSHA: Occupational Safety & Health Administration

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.
- B. Welding certificates.
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.
- B. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- C. Component Supports:
 - 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.02 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Minimum deflection as indicated on Drawings.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.03 RESTRAINT ACCESSORIES

- A. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

- B. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.02 INSTALLATION OF VIBRATION CONTROL DEVICES

- A. Provide vibration control devices for systems and equipment where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Section 07 72 00 "ROOF ACCESSORIES" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

3.03 ADJUSTING

- A. Adjust isolators after system is at operating weight.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with the Engineer before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain the Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by the Engineer.
 - 5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

PART 4 - MEASUREMENT AND PAYMENT

- A. Vibration Controls for HVAC as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.03 DEFINITIONS

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. NFPA: National Fire Protection Association
- D. OSHA: Occupational Safety & Health Administration

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
 - 2. Letter and Background Color: As indicated for specific application under Part 3.
 - 3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-taping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 1. Pipe size.

2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.04 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:
 1. Duct size.
 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution ducts. Arrows may be either integral with label or may be applied separately.
 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
 - 1. White letters on an ANSI Z535.1 safety-blue background.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

3.04 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.
- D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- E. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- F. Pipe-Label Color Schedule:
 - 1. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.

3.05 INSTALLATION OF DUCT LABELS

- A. Install plastic-laminated or self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.
 - 1. Provide labels in the following color codes:
 - a. For air supply ducts: White letters on blue background.
 - b. For air return ducts: White letters on blue background.
 - c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Mechanical*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Testing, Adjusting, and Balancing of Air Systems:
 - a. Constant-volume air systems.
 - 2. Testing, adjusting, and balancing of existing HVAC systems and equipment.
 - 3. Procedures for exhaust hoods.
 - 4. Duct leakage tests verification.
 - 5. Pipe leakage tests verification.
 - 6. UFAD plenum leakage tests verification.
 - 7. HVAC-control system verification.

1.02 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article herein.

- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.04 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.05 FIELD CONDITIONS

- A. Full City Occupancy: City will occupy the site and existing building during entire TAB period. Cooperate with City during TAB operations to minimize conflicts with City's operations.
- B. Partial City Occupancy: City may occupy completed areas of building before Substantial Completion. Cooperate with City during TAB operations to minimize conflicts with City's operations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning in accordance with the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "AIR DUCT ACCESSORIES."
 - 3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
 - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 23 07 13 "DUCT INSULATION," Section 23 07 16 "HVAC EQUIPMENT INSULATION," and Section 23 07 19 "HVAC PIPING INSULATION."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Pumps.
 - 3. Fans and ventilators.
 - 4. Terminal units.
 - 5. Condensing units.
 - 6. Energy-recovery units.
 - 7. Split-system air conditioners.
 - 8. Heat pumps.
 - 9. Coils.

3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

3.06 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

3.07 EDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from the Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.08 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.09 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of compressor(s), fan(s), and motors.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Entering and leaving refrigerant pressure and temperatures.

3.11 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.12 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.13 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 - 1. Verify HVAC control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).

2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
 3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 4. Check the refrigerant charge.
 5. Check the condition of filters.
 6. Check the condition of coils.
 7. Check the operation of the drain pan and condensate-drain trap.
 8. Check bearings and other lubricated parts for proper lubrication.
 9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.15 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
 2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.16 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Engineer's name and address.
 - 6. Contractor's name and address.
 - 7. Report date.
 - 8. Signature of TAB supervisor who certifies the report.
 - 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 10. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Nomenclature sheets for each item of equipment.
 - 12. Data for terminal units, including manufacturer's name, type, size, and fittings.

13. Notes to explain why certain final data in the body of reports vary from indicated values.
 14. Test conditions for fans performance forms, including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Heating coil, dry-bulb conditions.
 - e. Face and bypass damper settings at coils.
 - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - g. Settings for pressure controller(s).
 - h. Other system operating conditions that affect performance.
 15. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Apparatus-Coil Test Reports:
1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.

- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and speed.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan speed.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System fan and air-handling-unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F.
- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft..
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:

1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

J. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.18 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of the Engineer.
- B. The Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 - 2. If the second final inspection also fails, City may pursue other Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

PART 4 - MEASUREMENT AND PAYMENT

- A. Testing, Adjusting, and Balancing for HVAC as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, exposed supply, return and outdoor air.
 - 2. Outdoor, exposed outdoor air.

1.02 DEFINITIONS

- A. ASJ: All service jacket
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing and Materials
- D. CFC: Chlorofluorocarbons
- E. FSK: Foil-skrim kraft
- F. HCFC: Hydrochlorofluorocarbons
- G. ICC: International Code Council
- H. PVC: Polyvinyl chloride

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed : Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.02 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.03 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.04 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

- D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.05 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.06 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials are compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
 - 1. Materials are compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.07 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
 - 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
 - 6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII

7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
- D. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Sheet and roll stock ready for shop or field sizing.
 2. Finish and thickness are indicated in field-applied jacket schedules.
 3. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 4. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
- E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
- F. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.
 1. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
 2. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
 3. Aluminum Finish: Embossed.

2.09 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
 - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum or stainless steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

2.12 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING."

3.04 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- B. Comply with manufacturer's written installation instructions.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

- d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.05 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.06 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Comply with manufacturer's written installation instructions.
- B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- C. Insulate duct access panels and doors to achieve same fire rating as duct.
- D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 "Penetration Firestopping."

3.07 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "EXTERIOR PAINTING" and Section 09 91 23 "INTERIOR PAINTING."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by the Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless steel jackets.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by the Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.09 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, exposed supply and outdoor air.
 - 2. Indoor, exposed return located in unconditioned space.
 - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Supply-Air Duct and Plenum Insulation: Glass-fiber blanket, 2-1/2 inches thick and minimum R-8.0.
- B. Return-Air Duct and Plenum Insulation: Glass-fiber blanket, 2-1/2 inches thick and minimum R-8.0.
- C. Outdoor-Air Duct and Plenum Insulation: Glass-fiber blanket, 2-1/2 inches thick and minimum R-8.0.
- D. Exhaust-Air Duct and Plenum Insulation: Glass-fiber blanket, 2-1/2 inches thick and minimum R-8.0.

3.11 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- B. Outdoor-Air and Plenum Insulation: Glass-fiber blanket, 2-1/2 inches thick and minimum R-8.0.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 1. None.
- D. Ducts and Plenums, Exposed:
 1. None.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.

PART 4 - MEASUREMENT AND PAYMENT

A. Duct Insulation as specified herein shall be included in the measurement and payment for "Mechanical".

B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulation for HVAC piping systems.

1.02 DEFINITIONS

- A. ASJ: All service jacket
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing and Materials
- D. CFC: Chlorofluorocarbons
- E. FSK: Foil-skrim kraft
- F. HCFC: Hydrohlorofluorocarbons
- G. ICC: International Code Council
- H. PVC: Polyvinyl chloride
- I. PVDC: Polyvinylidene chloride

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports.
- C. Field quality-control reports.

1.05 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.06 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.02 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles herein for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
 - 1. Preformed Pipe Insulation without Jacket: Type II, Class 1, unfaced.
 - 2. Preformed Pipe Insulation with Jacket: Type II, Class 2, with factory-applied ASJ jacket.
 - 3. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
 - 4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.

2.03 INSULATING CEMENTS

- A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
- C. Glass-Fiber and Mineral Wool Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.04 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
- C. Flexible Elastomeric Adhesive: Solvent-based adhesive.
 - 1. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
 - 2. Wet Flash Point: Below 0 deg F.
 - 3. Service Temperature Range: 40 to 200 deg F.
 - 4. Color: Black.
- D. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.05 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

2. Service Temperature Range: 0 to plus 180 deg F.
 3. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: 0 to 180 deg F.
 3. Color: White.
- D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 3. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 2. Service Temperature Range: 0 to plus 180 deg F.
 3. Color: White.

2.06 LAGGING ADHESIVES

- A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 2. Service Temperature Range: 20 to plus 180 deg F.
 3. Color: White.

2.07 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
1. Permanently flexible, elastomeric sealant.
 - a. Service Temperature Range: Minus 150 to plus 250 deg F.
 - b. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
1. Fire- and water-resistant, flexible, elastomeric sealant.
 2. Service Temperature Range: Minus 40 to plus 250 deg F.
 3. Color: Aluminum.
- D. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

2.08 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
 5. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.09 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.

- 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 3) Tee covers.
- 4) Flange and union covers.
- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless Steel Jacket: ASTM A240/A240M.

- a. Sheet and roll stock ready for shop or field sizing.
- b. Material, finish, and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
- F. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.
- G. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.
 1. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
 2. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
 3. Aluminum Finish: Embossed.
- H. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

- I. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.
- J. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.10 FIELD-APPLIED FABRIC REINFORCING MESH

- A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
- B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.11 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.12 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches .
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.

- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Width: 3 inches.
 - 2. Film Thickness: 2 mils.
 - 3. Adhesive Thickness: 1.5 mils.
 - 4. Elongation at Break: 120 percent.
 - 5. Tensile Strength: 20 psi in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Width: 3 inches.
 - 2. Film Thickness: 6 mils.
 - 3. Adhesive Thickness: 1.5 mils.
 - 4. Elongation at Break: 145 percent.
 - 5. Tensile Strength: 55 psi in width.

2.13 SECUREMENTS

- A. Bands:
 - 1. Wing seals are primarily used for fastening bands together. Closed seals are occasionally used for large, 84-inch- (2130-mm-) diameter applications and where fastening bands are used with springs. Wing seals are reusable; closed seals are not.
 - 2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
 - 3. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.
- B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.
 4. For below-ambient services, apply vapor-barrier mastic over staples.
 5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING."

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using prefabricated fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with prefabricated fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation conforms to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A.** Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated and for horizontal applications, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive

- or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.09 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "EXTERIOR PAINTING" and Section 09 91 23 "INTERIOR PAINTING."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by the Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

- A. City will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by the Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- E. All insulation applications will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
- B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation is one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation is one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.
- D. Refrigerant Liquid Piping:
 - 1. All Pipe Sizes: Insulation is one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation is one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inches thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.
- C. Refrigerant Liquid Piping:
 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None.
- D. Piping, Exposed:
 1. PVC: 20 mils thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None.
- D. Piping, Exposed:
 1. PVC: 30 mils thick.

PART 4 - MEASUREMENT AND PAYMENT

- A. HVAC Piping Insulation as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Pressure regulators.
 - 6. Dielectric fittings.

1.02 DEFINITIONS

- A. ASME: American Society of Mechanical Engineers
- B. ASTM: American Society for Testing and Materials
- C. ANSI: American National Standards Institute
- D. AWS: American Welding Society
- E. CWP: Cold working pressure.
- F. NFPA: National Fire Protection Association
- G. NPS: Nominal pipe size
- H. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.
- I. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- J. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Piping specialties.
 - 2. Corrugated, stainless steel tubing with associated components.

3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 4. Pressure regulators. Indicate pressure ratings and capacities.
 5. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot.
 2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Welding certificates.
- C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- D. Field quality-control reports.
- E. Qualification Statements: For professional engineer.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

- D. Protect stored PE pipes and valves from direct sunlight.

1.08 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by City or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:
 - 1. Notify City no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without City's written permission.

1.09 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces.
- C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 22 05 53 "IDENTIFICATION OF PLUMBING PIPING AND EQUIPMENT."

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

- A. Obtain each product type from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 54 and California Plumbing Code 2022.
- B. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
- C. Natural-Gas System Pressure within Buildings:
 - 1. Two pressure ranges. Primary pressure is more than 0.5 psig, but not more than 5 psig, and is reduced to secondary pressure of 0.5 psig or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.04 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated, stainless steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig.
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 - 1. Copper-alloy convenience outlet and matching plug connector.
 - 2. Seals: Nitrile.
 - 3. Hand operated with automatic shutoff when disconnected.
 - 4. For indoor or outdoor applications.
 - 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
 - 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- D. Weatherproof Vent Cap:
 - 1. Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.05 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.06 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Body: Bronze, complying with ASTM B584.
 - 2. Ball: Chrome-plated bronze.
 - 3. Stem: Bronze; blowout proof.
 - 4. Seats: Reinforced TFE; blowout proof.
 - 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 6. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 7. CWP Rating: 600 psig.
 - 8. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.07 PRESSURE REGULATORS

- A. General Requirements:
 - 1. Single stage and suitable for natural gas.
 - 2. Steel jacket and corrosion-resistant components.
 - 3. Elevation compensator.
 - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80A.
 - 1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 - 2. Springs: Zinc-plated steel; interchangeable.
 - 3. Diaphragm Plate: Zinc-plated steel.
 - 4. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
 - 5. Orifice: Aluminum; interchangeable.
 - 6. Seal Plug: UV-stabilized, mineral-filled nylon.
 - 7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
 - 8. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
 - 9. Overpressure Protection Device: Factory mounted on pressure regulator.

10. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 5 psig.

2.08 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.09 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping in accordance with NFPA 54 and California Plumbing Code 2022 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and California Plumbing Code 2022 requirements for preventing accidental ignition.

3.02 INSTALLATION OF OUTDOOR PIPING

- A. Comply with NFPA 54 and California Plumbing Code 2022 for installation and purging of natural-gas piping.
- B. Install fittings for changes in direction and branch connections.
- C. Install pressure gauge downstream from each service regulator. Pressure gauges are specified in Section 22 05 19 "METERS AND GAUGES FOR PLUMBING PIPING."

3.03 INSTALLATION OF INDOOR PIPING

- A. Comply with NFPA 54 and California Plumbing Code 2022 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access. Do not locate valves within return air plenums.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
 - 2. Install sediment trap on both sides of regulators for gas reduction to 2 psig with valve and cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe

with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gauge downstream from each line regulator. Pressure gauges are specified in Section 22 05 19 "METERS AND GAUGES FOR PLUMBING PIPING."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "SLEEVES AND SLEEVE SEALS FOR HVAC PIPING."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "SLEEVES AND SLEEVE SEALS FOR HVAC PIPING."

3.04 INSTALLATION OF VALVES

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing, aluminum, or copper connector.

- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.05 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.06 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 23 05 29 "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT" for hangers, supports, and anchor devices.
- B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.07 PIPING CONNECTIONS

- A. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.
- B. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.

- C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.08 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 23 05 53 "IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT" for piping and valve identification.

3.09 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas in accordance with NFPA 54, the California Plumbing Code 2022, and authorities having jurisdiction.
 - 2. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports.

3.10 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

- A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

- A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:
 - 1. Annealed-temper, tin-lined copper tube with flared joints and fittings.
 - 2. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
 - 3. Aluminum tube with flared fittings and joints.
 - 4. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

2. Steel pipe with steel welding fittings and welded joints.
3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

3.13 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller are to be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves in branch piping for single appliance are to be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.

PART 4 - MEASUREMENT AND PAYMENT

- A. Facility Natural Gas Piping as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Steel pipe and fittings.
 - 3. Valves and specialties.
 - 4. Refrigerants.

1.02 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing and Materials
- D. ANSI: American National Standards Institute
- E. AWS: American Welding Society
- F. NPS: Nominal pipe size

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and refrigerated piping specialty.
- B. Shop Drawings:
 - 1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 2. Show interface and spatial relationships between piping and equipment.
 - 3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.04 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports: For each field quality control test and inspection.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Test Pressure for Refrigerant R-410A:
 - 1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig.
 - 2. Suction Tubing for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Tubing Lines: 535 psig.

2.02 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B280, Type ACR.
- B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.
- C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Brazing Filler Metals: AWS A5.8M/A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.
- G. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:
 - 1. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
 - 2. Housing: Copper.
 - 3. O-Rings: HNBR compatible with specific refrigerant.
 - 4. Tools: Manufacturer's approved special tools.
 - 5. Minimum Rated Pressure: 700 psig.

2.03 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap, including key end to remove core.
2. Core: Removable ball-type check valve with stainless steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

E. Refrigerant Locking Caps:

1. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
2. Material: Brass, with protective shroud or sleeve.
3. Refrigerant Identification: Color-coded, refrigerant specific based on AHRI Guideline N or Universal design.
4. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with AHRI 760 I-P and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 208 V ac coil.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- H. Thermostatic Expansion Valves: Comply with AHRI 750 I-P.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color-coded to show moisture content in parts per million (ppm).
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730 I-P.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Design: Reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 1.5.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with AHRI 730 I-P.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Design: Reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 1.5
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

N. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with AHRI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid-level indicator, and safety-relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 450 psig.
7. Maximum Operating Temperature: 250 deg F.

P. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.

- 4. Maximum Operating Temperature: 275 deg F.

2.04 REFRIGERANTS

- A. R-410A, ASHRAE 34: Pentafluoroethane/Difluoromethane

PART 3 - . EXECUTION

3.01 PIPING APPLICATION SCHEDULES

- A. Refrigerant: R-410A
- B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- D. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4 (DN 50 to DN 100): Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- E. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR, drawn-temper or annealed-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 1. Solenoid valves.
 2. Thermostatic expansion valves.
 3. Hot-gas bypass valves.
 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge if recommended by equipment manufacturer.
- M. Install flexible connectors at compressors.
- N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.03 INSTALLATION OF PIPING, GENERAL

- A. Drawings, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping in accordance with ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.

- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- M. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- N. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- P. Identify refrigerant piping and valves in accordance with Section 23 05 53 "Identification for HVAC Piping and Equipment."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.05 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with Section 23 05 29 "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT" for hangers, supports, and anchor devices.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 ft. or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting.
- E. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.06 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System must maintain test pressure at the manifold gauge throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves but not bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

PART 4 - MEASUREMENT AND PAYMENT

- A. Refrigerant Piping as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.

1.02 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing and Materials
- D. ANSI: American National Standards Institute
- E. AWS: American Welding Society
- F. EPA: Environmental Protection Agency
- G. HVAC: Heating, ventilation, and air conditioning
- H. NFPA: National Fire Protection Association
- I. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of the product:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of allduct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Welding certificates.
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article herein.

- B. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" .
- C. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather, construct of Type 304 or Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
 - 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
 - 3.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather, construct of Type 304 or Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- F. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.04 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G60 or G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G60 or G90.
 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick.
 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- E. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Factory- or Shop-Applied Antimicrobial Coating:
1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating is to be applied to the exterior surface.
 2. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Coating containing the antimicrobial compound is to have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 5. Shop-Applied Coating Color: Black or White.
 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- H. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- I. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.

2.05 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
 2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- C. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.
1. Source Limitations: Obtain fibrous-glass-free, natural-fiber duct liner from single manufacturer.
 2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
 3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- D. Polyolefin Duct Liner: Cross-linked, partially open-cell polyolefin foam sheet or roll materials, with reinforced aluminum foil facing and adhesive backing, complying with NFPA 90A or NFPA 90B; sheet (Type II) complying with ASTM C1427.
1. Source Limitations: Obtain polyolefin duct liner from single manufacturer.
 2. Foam Core Density: 1.5 pcf.
 3. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
 4. Minimum Noise Reduction Coefficient (NRC): 0.50 for 3/8-inch thickness, 0.45 for 5/8-inch thickness, 0.55 for 1-inch thickness, 0.55 for 2-1/8-inch thickness.
 5. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 6. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- E. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick stainless steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.
- F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.06 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.07 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- A. Drawings, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Install fire and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.
- M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCTWORK EXPOSED TO WEATHER

- A. All external joints are to be welded. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Single Wall:
 1. Ductwork is to be Type 304 or Type 316 stainless steel.
 2. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 23 07 13 "DUCT INSULATION."

3.04 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 2. Outdoor, Supply-Air Ducts: Seal Class A.
 3. Outdoor, Exhaust Ducts: Seal Class C.
 4. Outdoor, Return-Air Ducts: Seal Class C.
 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.06 DUCTWORK CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "AIR DUCT ACCESSORIES."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "EXTERIOR PAINTING" and Section 09 91 23 "INTERIOR PAINTING."

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by City, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.09 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use duct cleaning methodology as indicated in NADCA ACR.
- C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.10 STARTUP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 2.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 2.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
- C. Return Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 2.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
 - 2. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 2.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
- D. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 2.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
 - 2. Ducts Connected to Equipment Not Listed above:

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: A.
- c. SMACNA Leakage Class for Rectangular: 2.
- d. SMACNA Leakage Class for Round and Flat Oval: 2.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: A.
- c. SMACNA Leakage Class for Rectangular: 8.
- d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Equipment Not Listed Above:

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: A.
- c. SMACNA Leakage Class for Rectangular: 2.
- d. SMACNA Leakage Class for Round and Flat Oval: 2.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. PVC-Coated Ducts:

- a. Exposed to Airstream: Match duct material.
- b. Not Exposed to Airstream: Galvanized.

3. Stainless Steel Ducts:

- a. Exposed to Airstream: Match duct material.
- b. Not Exposed to Airstream: Galvanized.

4. Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

G. Liner:

- 1. Supply-Air Ducts: Flexible elastomeric, 5/8 inch thick.
- 2. Return-Air Ducts: Flexible elastomeric, 5/8 inch thick.
- 3. Exhaust-Air Ducts: Flexible elastomeric, 5/8 inch thick.

H. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

- 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
- 2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

- 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

- 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.
- I. Branch Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Conical spin in.
 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.

- c. Velocity 1500 fpm or Higher: 45-degree lateral.

PART 4 - MEASUREMENT AND PAYMENT

- A. Metal Ducts as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Flange connectors.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors.
 - 6. Duct access panel assemblies.
 - 7. Flexible connectors.
 - 8. Duct accessory hardware.

1.02 DEFINITIONS

- A. AMCA: Air Movement and Control Association International
- B. ASTM: American Society for Testing and Materials
- C. NFPA: National Fire Protection Association
- D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, or Building Information Modeling (BIM) model, drawn to scale, and coordinated with each other, using input from installers of the items involved.
- B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity balanced.
- B. Performance:
 - 1. Maximum Air Velocity: 1000 fpm.
 - 2. Maximum System Pressure: 3 inches wg.
 - 3. AMCA Certification: Test and rate in accordance with AMCA 511.
 - 4. Leakage:
 - a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
- C. Construction:
 - 1. Frame:
 - a. Hat shaped.
 - b. 16-gauge-thick, galvanized sheet steel, with welded or mechanically attached corners.
 - 2. Blades:
 - a. Multiple single-piece blades.
 - b. Center pivoted, maximum 6-inch width, 16-gauge-thick, galvanized sheet steel with sealed edges.

- 3. Blade Action: Parallel.
- D. Blade Seals: Felt, Vinyl foam, or Neoprene, mechanically locked.
- E. Blade Axles:
 - 1. Material: Galvanized steel or Stainless steel.
 - 2. Diameter: 0.20 inch.
- F. Tie Bars and Brackets: Aluminum or Galvanized steel.
- G. Return Spring: Adjustable tension.
- H. Bearings: Steel ball, Brass sleeve, or synthetic pivot bushings.
- I. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Chain pulls.
 - 4. Screen Mounting:
 - a. Front mounted in sleeve.
 - 1) Sleeve Thickness: 20 gauge minimum.
 - 2) Sleeve Length: 6 inches minimum.
 - 5. Screen Material: Galvanized steel or Aluminum.
 - 6. Screen Type: Insect.
 - 7. 90-degree stops.

2.03 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 2. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 - 3. Frames:
 - a. Hat-shaped, 16-gauge-thick, galvanized sheet steel or 18-gauge-thick stainless steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.

- b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized or Stainless steel; 16 gauge thick.
 - 5. Blade Axles: Galvanized steel or Stainless steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze, molded synthetic, oil-impregnated stainless steel sleeve, or Stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 - 7. Tie Bars and Brackets: Galvanized steel.
 - 8. Locking device to hold damper blades in a fixed position without vibration.
- B. Standard, Aluminum, Manual Volume Dampers:
- 1. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 2. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 - 3. Frames:
 - a. Hat-shaped, 0.10-inch-thick, aluminum sheet channels.
 - b. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 - 5. Blade Axles: Galvanized steel or Stainless steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze, molded synthetic, or stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 - 7. Tie Bars and Brackets: Aluminum.
 - 8. Locking device to hold damper blades in a fixed position without vibration.
- C. Jackshaft:
- 1. Size: 0.5-inch diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.04 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Vane Construction:

1. Single wall.

2.05 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:

- a. Double wall, rectangular.
- b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
- c. 24-gauge-thick galvanized steel or 0.032-inch thick aluminum or 24-gauge-thick stainless steel door panel.
- d. Vision panel.
- e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
- f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

- a. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum frame.

3. Number of Hinges and Locks:

- a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
- b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
- c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
- d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

B. Pressure Relief Access Door:

- 1. Door and Frame Material: Galvanized sheet steel.
 - a. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum or 24-gauge-thick stainless steel door panel.
- 2. Door: Single wall with metal thickness applicable for duct pressure class.
- 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
- 4. Factory set at 3.0 to 8.0 inches wg.
- 5. Doors close when pressures are within set-point range.
- 6. Hinge: Continuous piano.
- 7. Latches: Cam.
- 8. Seal: Neoprene or foam rubber.

2.06 DUCT ACCESS PANEL ASSEMBLIES

- A. Panel and Frame: Minimum thickness 16-gauge stainless steel.
- B. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- C. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- D. Minimum Pressure Rating: 10 inches wg positive or negative.

2.07 FLEXIBLE CONNECTORS

- A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Materials: Flame-retardant or noncombustible fabrics.
- D. Coatings and Adhesives: Comply with UL 181, Class 1.
- E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- G. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.08 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.09 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 1. Galvanized Coating Designation: G60 or G90.
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 2 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-ft. spacing.
 - 8. Upstream from turning vanes.
 - 9. Control devices requiring inspection.
 - 10. Elsewhere as indicated.

- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Install duct test holes where required for testing and balancing purposes.
- O. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

PART 4 - MEASUREMENT AND PAYMENT

- A. Air Duct Accessories as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ceiling-mounted ventilators.
 - 2. Centrifugal ventilators - roof downblast.

1.02 DEFINITIONS

- A. AMCA: Air Movement and Control Association International
- B. HVAC: Heating, ventilation, and air conditioning
- C. Retain terms that remain after this Section has been edited for a project. Include only essential definitions or acronyms not well understood by the affected industry or trade.
- D. NFPA: National Fire Protection Association
- E. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association
- F. UL: Underwriters Laboratories

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material thickness and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Prefabricated roof curbs.
 - 9. Fan speed controllers.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.
- C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.04 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.02 CEILING-MOUNTED VENTILATORS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.
- C. Back-draft damper: Integral.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 4. Motion Sensor: Motion detector with adjustable shutoff timer.
 - 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
 - 6. Filter: Washable aluminum to fit between fan and grille.
 - 7. Isolation: Rubber-in-shear vibration isolators.
 - 8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.03 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

- A. Housing: Downblast; removable spun-aluminum dome top or galvanized-steel mushroom-domed top; square, one-piece aluminum base with venturi inlet cone.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades
- C. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 - 6. Fan and motor isolated from exhaust airstream.
- D. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 - 6. Spark-resistant, all-aluminum wheel construction.
 - 7. Mounting Pedestal: Galvanized steel with removable access panel.
- E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: 8 to 12 inches.
 - 3. Metal Liner: Galvanized steel.
 - 4. Mounting Pedestal: Galvanized steel with removable access panel.

2.04 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.05 SOURCE QUALITY CONTROL

- A. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.
- B. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
 - 1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 07 72 00 "ROOF ACCESSORIES" for installation of roof curbs.
 - 2. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
 - 3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48.13 "VIBRATION CONTROLS FOR HVAC."
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 23 05 53 "IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT."

3.02 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "AIR DUCT ACCESSORIES."

3.03 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
- B. Ground equipment according to Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.04 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.05 STARTUP SERVICE:

- A. Perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
 - 6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 7. Adjust belt tension.
 - 8. Adjust damper linkages for proper damper operation.
 - 9. Verify lubrication for bearings and other moving parts.
 - 10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 12. Shut unit down and reconnect automatic temperature-control operators.
 - 13. Remove and replace malfunctioning units and retest as specified above.

3.06 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Comply with requirements in Section 23 05 93 "TESTING, ADJUSTING, AND BALANCING FOR HVAC."

3.07 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties.
 - 3. Fans and components will be considered defective if they do not pass tests and inspections.

4. Prepare test and inspection reports.

3.09 DEMONSTRATION

- A. Train City's maintenance personnel to adjust, operate, and maintain centrifugal fans.

PART 4 - MEASUREMENT AND PAYMENT

- A. HVAC Power Ventilators as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 37 13.13

AIR DIFFUSERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Square ceiling diffusers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SQUARE CEILING DIFFUSERS

- A. Material: Steel or Aluminum.
- B. Finish: Baked enamel, color selected by the Engineer.
- C. Face Size: 24 by 24 inches.
- D. Face Style: Three cone.
- E. Mounting: Surface T-bar.
- F. Pattern: Fixed.
- G. Dampers: Radial opposed blade.
- H. Accessories:
 - 1. Equalizing grid.
 - 2. Plaster ring.
 - 3. Safety chain.
 - 4. Wire guard.
 - 5. Sectorizing baffles.
 - 6. Operating rod extension.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify the Engineer for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.02 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

PART 4 - MEASUREMENT AND PAYMENT

- A. Air Diffusers as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 37 13.23
REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fixed face grilles.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 GRILLES

- A. Fixed Face Grille:
 - 1. Material: Aluminum.
 - 2. Finish: Baked enamel, color selected by the Engineer.
 - 3. Face Blade Arrangement: Horizontal; spaced 1/2 inch apart.
 - 4. Face Arrangement: Perforated core.
 - 5. Core Construction: Integral or Removable.
 - 6. Frame: 1-1/4 inches wide.
 - 7. Mounting: Lay in.
 - 8. Filter: None.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify the Engineer for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.02 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

PART 4 - MEASUREMENT AND PAYMENT

- A. Registers and Grilles as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 37 23
HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Hooded ventilators.
 - 2. Goosenecks.

1.02 DEFINITIONS

- A. AMCA: Air Movement and Control Association International
- B. HVAC: Heating, ventilation, and air conditioning
- C. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gravity ventilators.
 - 1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
 - 2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.
- F. Delegated Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of shop-fabricated ventilators.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.06 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided by the Contractor.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Ventilators shall withstand the effects of gravity loads within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors.
- B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."
- D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.
- E. Capacities and Characteristics: as schedule in the drawings.

2.02 HOODED VENTILATORS

- A. Description: Hooded rectangular penthouse for intake air.
- B. Source Limitations: Obtain hooded ventilators from single manufacturer.
- C. Construction:
 - 1. Material, Aluminum: Thickness required to comply with structural performance requirements, but not less than 0.063-inch- thick base and 0.050-inch- thick hood; suitably reinforced.
 - 2. Insulation: None.
 - 3. Bird Screening: Aluminum, 1/2-inch- square mesh or flattened, expanded aluminum, 3/4-inch diamond mesh wire.
- D. Dampers:
 - 1. Location: Hood neck or Curb damper tray.
 - 2. Control: Gravity backdraft.

2.03 GOOSENECKS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of 0.052-inch-thick, galvanized-steel sheet.
- B. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inchwire.
- C. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch.
- D. Galvanized-Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
 - 2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
- E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
 - 1. Configuration: Built-in cant and mounting flange.
 - 2. Overall Height: 12 inches.

2.04 SOURCE QUALITY CONTROL

- A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

2.05 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.
- D. Stainless Steel Sheet: ASTM A666, Type 304, with No. 4 finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
- F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Secure gravity ventilators to roof curbs with zinc-plated hardware. Use concealed anchorages where possible. Refer to Section 07 72 00 "Roof Accessories."
- C. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.
- D. Install gravity ventilators with clearances for service and maintenance.
- E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 92 00 "JOINT SEALANTS" for sealants applied during installation.
- G. Label gravity ventilators according to requirements specified in Section 23 05 53 "IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT."
- H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- J. Refer to Section 07 72 00 "ROOF ACCESSORIES" for flashing and counterflashing of roof curbs.

3.02 DUCT CONNECTIONS

- A. Duct installation and connection requirements are specified in Section 23 31 13 "METAL DUCTS." Drawings indicate general arrangement of ducts and duct accessories.

3.03 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

PART 4 - MEASUREMENT AND PAYMENT

- A. HVAC Gravity Ventilators as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 72 23.19

PACKAGED INDOOR FIXED PLATE ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fixed-plate, total heat exchangers in packaged, indoor, energy-recovery units.

1.02 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- B. AHRI: Air-Conditioning, Heating, and Refrigeration Institute
- C. AMCA: Air Movement and Control Association International
- D. HVAC: Heating, ventilation, and air conditioning
- E. MERV: Minimum efficiency rating value
- F. NEMA: National Electrical Manufacturers Association
- G. NFPA: National Fire Protection Association
- H. UL: Underwriters Laboratories

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For packaged, indoor, fixed-plate, energy-recovery units.
 1. Include plans, elevations, sections, details, and mounting details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided by the Contractor.

1.07 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, indoor, fixed-plate, energy-recovery units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- B. ASHRAE Compliance:
 - 1. Applicable requirements in ASHRAE 62.1.
 - 2. Capacity ratings for fixed-plate energy-recovery units shall comply with ASHRAE 84.
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- D. UL Compliance:
 - 1. Packaged heat-recovery ventilators shall comply with requirements in UL 1812 or UL 1815.
 - 2. Electric coils shall comply with requirements in UL 1995.
- E. Comply with CSA 439.

2.02 CAPACITIES AND CHARACTERISTICS

- A. Type: Fixed-plate sensible energy-recovery unit.
- B. Airflow: 30-130 cfm
- C. Total Summer Effectiveness: 61% at 49 CFM flowrate with 95 deg F dry bulb/78 deg F wet bulb OA and 75 deg F dry bulb/63 deg F wet bulb RA.
- D. Total Winter Effectiveness: 75% at 49 CFM flowrate with 35 deg F dry bulb/33 deg F wet bulb OA and 70 deg F dry bulb/58 deg F wet bulb RA.

2.03 PACKAGED, INDOOR, FIXED-PLATE TOTAL ENERGY RECOVERY UNITS

- A. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch-thick expanded polystyrene foam insulation faced with a cleanable foil face on all exposed surfaces, knockouts for electrical connections, and lifting lugs.
- C. Fixed-Plate Total Heat Exchanger:
 - 1. Casing: Galvanized, painted steel, 22 gauge.
 - 2. Plates: Evenly spaced and sealed and arranged for cross-flow.
 - a. Plate Material: Polymer membrane with selective hygroscopicity and moisture permeability, and gas barrier properties.
- D. Supply and Exhaust Fans: Backward curved fan, statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
 - 1. Motor and Drive: Direct driven, electrically commutated (EC).
 - 2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- E. Filters:
 - 1. Energy Core shall be protected by MERV 8 rated, spun polyester, disposable filters in both airstreams.
 - 2. 1-inch-thick MERV 13 disposable pleated filter shall be located in the outdoor air stream.
 - 3. All filters shall be accessible from the exterior of the unit.
- F. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls, so only external connections are required during installation.
 - 1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
 - 2. Include fused disconnect switches.

2.04 CONTROLS

- A. Control Panel: Solid-state, programmable, microprocessor-based control unit for wall mounting.
- B. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
- C. Motion (Occupancy) Sensor: Passive infrared sensor for ceiling mounting with adjustable time-off delay of up to 30 minutes to energize unit.
- D. Dirty filter switch.

- E. Low-Voltage Transformer: Integral transformer to provide control voltage to unit from primary incoming electrical service.

2.05 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060.
- C. Fan Performance Rating: Comply with AMCA 211 and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency according to AMCA 210/ASHRAE 51.
- D. Fan Sound Ratings: Comply with AMCA 301 or AHRI 260 (IP). Air-handling unit fan sound ratings shall comply with AMCA 301 or AHRI 260 (IP).
- E. UL Compliance:
 - 1. Packaged fixed plate energy recovery units shall comply with requirements in UL 1812; or UL 1815.
 - 2. Electric Coils: Comply with UL 1995.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine casing insulation materials and filter media before packaged, indoor, fixed-plate, energy-recovery unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- B. Install packaged, indoor, fixed-plate, energy-recovery units, so supply and exhaust airstreams flow in opposite directions.
 - 1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to interior components.
 - 2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
 - 3. Access doors and panels are specified in Section 23 33 00 "AIR DUCT ACCESSORIES."
- C. Suspended Units: Suspend and brace units from structural-steel support frame, using threaded steel rods and spring hangers. Comply with requirements for vibration-isolation devices specified in Section 23 05 48.13 "VIBRATION CONTROLS FOR HVAC."
- D. Install units with clearances for service and maintenance.
- E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

3.02 DUCTWORK CONNECTIONS

- A. Comply with requirements for ductwork according to Section 23 31 13 "METAL DUCTS."
- B. Connect duct to units with flexible connections. Comply with requirements in Section 23 33 00 "AIR DUCT ACCESSORIES."

3.03 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished with units but not factory mounted.
- B. Connect wiring according to Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
- C. Ground equipment according to Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
- D. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.04 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: City will engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Packaged, indoor, fixed-plate, energy-recovery units will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.06 DEMONSTRATION

- A. Train the City's maintenance personnel to adjust, operate, and maintain air-to-air energy-recovery units.

PART 4 - MEASUREMENT AND PAYMENT

- A. Packaged Indoor Fixed Plate Energy Recovery Units as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.02 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- B. ARI: Air-Conditioning and Refrigeration Institute
- C. HVAC: Heating, ventilation, and air conditioning
- D. NEMA: National Electrical Manufacturers Association
- E. NFPA: National Fire Protection Association

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each air-handling unit fan.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.08 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "CAST-IN-PLACE CONCRETE."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: One year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Filters: Permanent, cleanable.

2.02 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by the Engineer, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.03 ACCESSORIES

- #### **A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.**

- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Drain Hose: For condensate.
- F. Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor economizer cycle.
 - 4. Monitor cooling load.
 - 5. Monitor air distribution static pressure and ventilation air volumes.

2.04 CAPACITIES AND CHARACTERISTICS

- A. As scheduled on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 07 72 00 "ROOF ACCESSORIES." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.02 CONNECTIONS

- A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.04 DEMONSTRATION

- A. Train City's maintenance personnel to adjust, operate, and maintain units.

PART 4 - MEASUREMENT AND PAYMENT

- A. Split-System Air-Conditioners as specified herein shall be included in the measurement and payment for "Mechanical".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 00 10

SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Supplemental requirements generally applicable to the Work specified in Division 26.

1.02 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied unless permitted under the following conditions:

1. Notify the Engineer no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the Engineer's written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Exercising generators.
 - b. Emergency lighting.
 - c. Elevators.
 - d. Fire-alarm systems.

B. Arrange to provide temporary electrical service or power in accordance with requirements specified in 01 50 00 "TEMPORARY FACILITIES AND CONTROLS".

1.03 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At pre-construction meeting, and periodically thereafter as dates change, provide schedule for electrical installation work to the Engineer including, but not limited to, milestone dates for the following activities:

B. Operation and Maintenance Data:

1. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.

- g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
- h. Manufacturer's instructions for setting field-adjustable components.
- i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
- j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
- k. Exterior pole inspection and repair procedures.

C. Software:

- 1. Program Software Backup: Provide username and password for approved online or cloud solution and USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
- 2. Provide to City upgrades and unrestricted licenses for Government use for installed and backup software, including operating systems and programming tools required for operation and maintenance.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Engineer for resolution of conflicting requirements.

3.02 FIELD QUALITY CONTROL

- A. Adminstrant for Power-Limited Electrical Tests and Inspections:
 - 1. Administer and self-perform tests and inspections.

3.03 CLEANING

- A. Waste Management:
 - 1. Follow specification 01 74 19 "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL"
 - 2. Coordinate removal of existing electrical equipment with City.

3.04 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. Demonstrate to City's maintenance and clerical personnel how to operate the following systems and equipment:

- a. Lighting control devices specified in Section 26 09 23 "LIGHTING CONTROL DEVICES."
2. Train City's maintenance personnel on the following topics:
 - a. How to operate and maintain devices specified in Section 26 09 23 "LIGHTING CONTROL DEVICES."
 - b. How to operate and maintain hardware and software specified in Section 26 09 43.16 "ADDRESSABLE LUMINAIRE LIGHTING CONTROLS."
 - c. How to operate and maintain luminaires and photoelectric controls specified in Section 26 56 19 "LED EXTERIOR LIGHTING."
 - d. How to adjust, operate, and maintain the JM Test System electrical test bench equipment.
3. Allow City to record training sessions.

3.05 PROTECTION OF EXISTING EQUIPMENT

- A. Existing equipment is to remain in operation and is to be protected in place during construction.
- B. Install roof mounted equipment in accordance with the roof warranty requirements to maintain existing roof warranty.

PART 4 - MEASUREMENT AND PAYMENT

- A. Supplemental Requirements for Electrical as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600 V or less.
 - 2. Aluminum building wire rated 600 V or less.
 - 3. Metal-clad cable, Type MC, rated 600 V or less.
 - 4. Fire-alarm wire and cable.
 - 5. Connectors, splices, and terminations rated 600 V and less.

1.02 DEFINITIONS

- A. ASTM: American Society of Testing Materials
- B. AWG: American Wire Gauge

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.

2.02 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Aluminum.
 - 2. Type: One or Two hole with standard barrels.
 - 3. Termination: Mechanical or Compression.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper; solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- B. Branch Circuits:
 - 1. Copper, Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

3.03 G METHODS

- A. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- B. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.

3.04 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33.13 "CONDUITS FOR ELECTRICAL SYSTEMS" prior to pulling conductors and cables.

- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."

3.05 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

3.06 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING."

3.08 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "PENETRATION FIRESTOPPING."

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Electrical Power Supply*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.

- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Grounding and bonding conductors.
 - 2. Grounding and bonding bushings.
 - 3. Grounding and bonding hubs.
 - 4. Grounding and bonding connectors.

1.02 DEFINITIONS

- A. AWG: American Wire Gauge

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color, in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. ASTM - Bare Copper Grounding and Bonding Conductor:
 - 1. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.02 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure.

Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Bonding Bushing:

- 1. General Characteristics: Threaded bushing with insulated throat.

D. UL KDER - Grounding Bushing:

- 1. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.03 GROUNDING AND BONDING HUBS

A. Description: Hubs with certified grounding or bonding locknut.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Grounding and Bonding Hub:

- 1. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.04 GROUNDING AND BONDING CONNECTORS

A. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- B. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:
 - 1. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.

2.05 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- C. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
 - 1. General Characteristics: Zinc-alloy one-piece construction; six terminating points; gangable.
- D. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:
 - 1. General Characteristics: Copper body and polycarbonate cover; four terminating points.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.02 SELECTION OF GROUNDING AND BONDING CONDUCTORS

- A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
- B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
- C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
- D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
- E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
- F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
- G. Underground Grounding Conductors: Install bare copper conductor, refer to plans for minimum size.
 - 1. Bury at least 24 inch below grade.

3.03 SELECTION OF CONNECTORS

- A. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.04 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
 - 2. Consult Engineer for resolution of conflicting requirements.
- C. Special Techniques:

1. Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Grounding and Bonding for Piping:
 - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
 - h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.
3. Equipment Grounding:
 - a. Install insulated equipment grounding conductors with feeders and branch circuits.

- b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - 8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:

- 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
- 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
- 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

B. Nonconforming Work:

- 1. Grounding system will be considered defective if it does not pass tests and inspections.
- 2. Remove and replace defective components and retest.

C. Prepare test and inspection report.

3.06 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by the City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Grounding and Bonding for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.02 DEFINITIONS

- A. EMT: Electrical Metallic Tubing
- B. ERMC: Electrical Rigid Metal Conduit
- C. IMC: Intermediate Metal Conduit

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
1. Hangers. Include product data for components.
 2. Slotted support systems.
 3. Equipment supports.
 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated Design Submittals: For hangers and supports for electrical systems.
1. Include design calculations and details of hangers.
 2. Include design calculations for seismic restraints.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 3. Channel Width: Selected for applicable load criteria.
 - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: All steel springhead type.
7. Hanger Rods: Threaded steel.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "METAL FABRICATIONS" for steel shapes and plates.

PART 3 - EXECUTION

3.01 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA NEIS 101
 2. NECA NEIS 102.
 3. NECA NEIS 105.
 4. NECA NEIS 111.
- B. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways specified in Section 26 05 33.13 "CONDUITS FOR ELECTRICAL SYSTEMS."
- D. Comply with requirements for boxes specified in Section 26 05 33.16 "BOXES AND COVERS FOR ELECTRICAL SYSTEMS."
- E. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 26 05 48.16 "SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."
- F. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- G. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 20 percent in future without exceeding specified design load limits.

- H. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.02 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, IMC may be supported by openings through structure members, in accordance with NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers, nuts and Beam clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

PART 4 - MEASUREMENT AND PAYMENT

- A. Hangers and Supports for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

Section includes furnishing and installing complete raceway systems, concrete encased conduits for underground duct bank raceway systems and other related work complete as indicated on the Drawings and as specified herein.

1.02 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean the City.

- A. American National Standards Institute (ANSI) / National Electrical Manufacturers Association (NEMA)
 - FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
- B. National Fire Protection Association (NFPA)
 - NFPA 70 National Electrical Code (NEC)
- C. Underwriters Laboratories (UL)
 - UL 360 Liquid-Tight Flexible Metal Conduit
 - UL 1660 Liquid-Tight Flexible Nonmetallic Conduit

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00, SUBMITTAL PROCEDURES.
- B. Submit product data consisting of manufacturers published specification sheets and catalog data for all raceways, fittings, and accessories.
- C. Submit concrete mix design as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, for duct banks.
 - 1. Product data shall be marked to indicate the specific items to be furnished. Where multiple products or multiple raceway types or sizes are shown on the same specification sheet or catalog page, clearly mark all items to be provided, or submit separate pages for each item.

1.04 QUALITY ASSURANCE

- A. All raceways of each type shall be the end product of one manufacturer. Similar raceway types, such as IMC, PVC, and GRS, need not be the product of the same manufacturer.
- B. All fittings and accessories for each type of raceway shall be the end product of one manufacturer.
- C. All raceways, fittings, and accessories, to the extent that UL standards have been established as of the bid date, shall be UL listed and UL labeled.

- D. All raceways shall be delivered, stored, and protected to prevent damage due to construction activity, damage from weather, and to prevent the entrance of foreign materials prior to installation.

PART 2 - PRODUCTS

2.01 GALVANIZED RIGID STEEL CONDUIT (GRS)

- A. Provide GRS conduit for all exterior above grade medium and high voltage cabling and wiring, and for all exterior above grade secondary voltage wiring.
- B. Provide Allied, Republic Steel, Triangle, or equal hot galvanized rigid conduit with threads hot galvanized after cutting, minimum size 3/4 inch.
- C. Provide O.Z. Gedney, Steel City, Appleton, or equal rigid conduit fittings, couplings and accessories. Fittings and accessories shall be threaded and plated.
 - 1. Provide O.Z. Gedney type SBLG, or equal, zinc plated steel insulating bushings with tin plated copper grounding saddle and stainless steel clamping tension body, for conduit terminations within enclosures..
 - 2. Provide 3/4 inch to 2 inch zinc plated steel, 2-1/2 inch to 6 inch zinc plated malleable iron locknuts for securing conduit terminations at enclosures with threaded hubs, and for use outside enclosures without threaded hubs, O.Z. Gedney type 1 standard, or O.Z. Gedney type SLG sealing type where exposed to the weather, or equal.
 - 3. Provide galvanized steel conduit couplings for connecting conduits. Conduit manufacturer's factory fabricated coupling systems, such as Allied Conduit Threaded Kwik-Couple, or equal, are acceptable.

2.02 INTERMEDIATE METAL CONDUIT (IMC)

- A. Provide galvanized IMC, in lieu of galvanized rigid steel, for all exterior above grade secondary voltage wiring.
- B. Provide Allied, Republic Steel, Triangle, or equal hot galvanized intermediate metal conduit with threads hot galvanized after cutting, minimum size 3/4 inch.
- C. Fittings and accessories for IMC conduit shall be the same as for GRS.

2.03 RIGID NONMETALLIC CONDUIT (PVC)

- A. Provide Allied, JM Eagle, Carlon, Cantex, or equal heavy wall Schedule 40 rigid polyvinyl chloride (PVC) conduit suitable for direct burial, installed in concrete encasement, for all below grade conduit runs and ductbanks for medium voltage cabling and wiring, and for secondary voltage cabling and wiring. Concrete encasement shall be a minimum of 3 inches on all sides. See POLB Electrical Standard Plan E9.
- B. Provide exterior above grade Schedule 40 and Schedule 80 PVC conduit for secondary voltage cabling and wiring, as specifically indicated on the Drawings.
- C. Provide Schedule 40 PVC conduit for all below grade and exterior above grade individual ground conductors run without phase conductors, where ground conductors are required or shown to be in raceway.
- D. Schedule 40 PVC conduit shall be heavy wall, suitable for direct burial whether direct buried or concrete encased, sunlight resistant, suitable for 90-degree conductors, with manufactured standard radius elbows, except raceways for medium voltage cables shall use 48 inches radius 45-degree and 90-degree bends.

- E. PVC conduit shall be plain end or bell end, at Contractor's option. Couplings and connectors shall be PVC, solvent cement applied, threaded for connection to nonmetallic conduits or enclosures, and with solvents provided by, or specifically recommended by, the conduit manufacturer. All conduit terminations in hand holes, manholes or cable vaults shall be with manufactured bell end with flared edges to facilitate cable pulling, and conduits not used in this project capped with poly plugs with pulling eye.

2.04 LIQUID TIGHT FLEXIBLE METAL CONDUIT

- A. Liquidtight Flexible Nonmetallic Conduit: UL 1660, Nonmetallic, liquid-tight conduit with a polyvinyl chloride reinforced core. Conduit must conform to NEC 351B. Electri-Flex Liguatite® Type LNM-P, Kellems Polytuff I or equal.
- B. Liquidtight Flexible Metallic Conduit: UL 360, Interlocked steel construction with a polyurethane jacket, Electri-Flex Liguatite® type CEA or equal.
- C. Fittings for Liquidtight Flexible Metallic Conduit: ANSI/NEMA FB 1.
- D. Fittings for Liquidtight Flexible Nonmetallic Conduit: ANSI/NEMA FB 1.

2.05 DUCT SPACERS

- A. All rigid nonmetallic conduit in runs of two or more shall be spaced and held uniformly in position using Carlon Snap-Loc duct spacers or equal. Duct spacers shall have an open web design to allow duct bank encasement concrete to flow freely through the spacer to completely encase the conduits.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install raceways and their accessories according to applicable codes.
- B. Cut raceway ends square, ream, and extend maximum distance into all couplings and connectors. Tighten all fittings securely.
- C. Provide and install manufactured end caps on all raceway ends during construction to prevent the entrance of water or dirt. Tape, as a cover, is not permitted.
- D. All raceways after final assembly in place shall be thoroughly cleaned and a mandrel correctly sized for each size of conduit shall be pulled through all raceways prior to installing wires or pull cords. Mandreling shall be done in the presence of the Engineer. Duct plugs shall be installed immediately after cleaning
- E. All elbows shall be factory elbows.
- F. Size all raceways per code unless specifically noted to be larger on the Drawings.

3.02 EXISTING UTILITIES

- A. Existing utilities shown on the Drawings have been plotted from available records. No guarantee is made as to the accuracy of the locations indicated, and is shown for whatever benefit the Contractor may derive therefrom.
- B. The Contractor shall locate all utility lines prior to commencing work.
- C. Protect utilities from damage and promptly have repaired all active utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.
- D. Adjust the depth of electrical utilities to avoid existing utilities with no change to Contract price.

3.03 TRENCHING

- A. Trenching shall be to depths as required by code, the particular installation, or as shown on the Drawings, whichever is deeper. Trenching shall be in accordance with Section 31 00 00, EARTHWORK.
- B. Trench bottom shall be free of debris and graded smooth.
- C. Separation between new electrical utilities and other utilities shall be 12 inches when running parallel and 6 inches when crossing minimum both vertical and horizontal, and water lines shall be 3 foot minimum (horizontal), except where shown otherwise on the Drawings.

3.04 GALVANIZED RIGID STEEL CONDUIT (GRS) AND INTERMEDIATE METAL CONDUIT (IMC)

- A. All connections shall be watertight.

3.05 PULL CORDS

- A. Nylon type pull cords, 3/8 inch minimum shall be included in all installed empty raceway.
- B. All raceways shall be sloped to drain to nearest manhole.

PART 4 - MEASUREMENT AND PAYMENT

- A. Conduit for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

This Section includes furnishing and installing all pull boxes, junction boxes, and terminal boxes to permit pulling and installation of terminal blocks when required, according to these Specifications, whether specifically shown on the Drawings or not.

1.02 DEFINITIONS

- A. NEMA: National Electrical Manufacturers Association

1.03 SUBMITTALS

- A. Submit product data for each item specified in accordance with Section 01 33 00, SUBMITTAL PROCEDURES and Section 26 05 01 BASIC MATERIALS AND METHODS.

1.04 QUALITY ASSURANCE

- A. Junction boxes and pull boxes shall be listed by Underwriters Laboratories (UL) for the purpose intended.
- B. Codes and Standards: Comply with the provisions of National Electrical Manufacturers Association (NEMA).

PART 2 - PRODUCTS

2.01 JUNCTION AND PULLBOXES

- A. NEMA 4X Boxes: Fiberglass or Stainless Steel, Gasketed, Corrosion resistant.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Size junction or pull boxes to meet the requirements of the National Electrical Code (NEC), except where indicated to be larger.
- B. Outdoor, exposed to weather: Use NEMA 3R finish boxes, see Section 26 24 16, PANELBOARDS.

PART 4 - MEASUREMENT AND PAYMENT

- A. Boxes for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 33.23

SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Surface metal raceways and fittings.
 - 2. Surface nonmetallic raceways.
 - 3. Strut-type channel raceways and fittings.
 - 4. Wireways and auxiliary gutters.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Surface metal raceways and fittings.
 - 2. Surface nonmetallic raceways.
 - 3. Strut-type channel raceways and fittings.
 - 4. Wireways and auxiliary gutters.
- B. Samples:
 - 1. Surface metal raceway nonmetallic cover samples for initial selection.
 - 2. Surface nonmetallic raceway samples for initial selection.
 - 3. Strut-type channel raceway nonmetallic covers for initial selection.
 - 4. Nonmetallic wireway and auxiliary gutter samples for initial selection.
- C. Sustainable design submittals.
 - 1. Surface metal raceways and fittings.
 - 2. Surface nonmetallic raceways.
 - 3. Strut-type channel raceways and fittings.
 - 4. Wireways and auxiliary gutters.

1.03 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions:
 - 1. Surface metal raceways and fittings.
 - 2. Surface nonmetallic raceways.
 - 3. Strut-type channel raceways and fittings.
 - 4. Wireways and auxiliary gutters.

PART 2 - PRODUCTS

2.01 SURFACE METAL RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN RJBT; including UL 5.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesives and solvents used with nonmetallic components:
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Samples:
 - a. Surface Metallic Raceway Nonmetallic Cover Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch long.

C. UL RJBT - Surface Metal Raceways and Fittings with Metal Covers:

1. Options:
 - a. Galvanized steel base with snap-on covers.
 - b. Wiring Channels: Single Dual Triple. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

D. UL RJBT - Surface Metal Raceways and Fittings with Nonmetallic Covers:

1. Additional Characteristics: UL 94, V-0 requirements for self-extinguishing characteristics.
2. Options:
 - a. Galvanized steel base with snap-on covers.
 - b. Wiring Channels: Single Dual Triple. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

2.02 SURFACE NONMETALLIC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:
 - a. UL CCN RJTX; including UL 5A.
 - b. UL 94, V-0 requirements for self-extinguishing characteristics.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesives and solvents:
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Samples:
 - a. Surface Nonmetallic Raceway Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch long.

C. UL RJTX - Surface Nonmetallic Raceways and Fittings with Nonmetallic Covers:

1. Options:
 - a. Provide texture and color selected by Engineer from manufacturer's standard colors.
 - b. Wiring Channels: Single Dual. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

D. UL RJTX - Surface Nonmetallic Raceways and Fittings with Metallic Covers:

1. Options:
 - a. Wiring Channels: Single Dual. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

2.03 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:
 - a. UL CCN RIUU; including UL 5B.
 - b. UL 94, V-0 requirements for self-extinguishing characteristics.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesives and solvents used with nonmetallic components:
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Samples:

- a. Strut-Type Channel Raceway Nonmetallic Covers for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch long.
- C. UL RIUU - Strut-Type Channel Raceways and Fittings with Metallic Covers:
 - 1. Options:
 - a. Manufacturer's standard enamel finish in color selected by Port Prime coated, ready for field painting.
- D. UL RIUU - Strut-Type Channel Raceways and Fittings with Nonmetallic Covers:
 - 1. Additional Characteristics: UL 94, V-0 requirements for self-extinguishing characteristics.
 - 2. Options:
 - a. Provide texture and color selected by Engineer from manufacturer's standard colors.

2.04 WIREWAYS AND AUXILIARY GUTTERS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. UL CCN ZOYX; including UL 870.
 - b. UL 94, V-0 requirements for self-extinguishing characteristics.
- B. Source Quality Control:
 - 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
 - 2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesives and solvents used with nonmetallic components:
 - 3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
 - 4. Samples:
 - a. Nonmetallic Wireway and Auxiliary Gutter Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch long.
- C. UL ZOYX - Metal Wireways and Auxiliary Gutters:
 - 1. Additional Characteristics:
 - a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - b. Finish: Manufacturer's standard enamel finish.

2. Options:
 - a. Degree of Protection: Type 12 unless otherwise indicated.
 - b. Wireway Covers: Hinged type unless otherwise indicated.

D. UL ZOYX - Nonmetallic Wireways and Auxiliary Gutters:

1. Additional Characteristics:
 - a. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings must match and mate with wireways as required for complete system.
 - b. PVC Solvents and Adhesives: As recommended by wireway manufacturer.
2. Options:
 - a. Material:
 - 1) Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover must be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections must be flanged and have stainless steel screws and oil-resistant gaskets.
 - 2) PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 1. Auxiliary Gutters: Article 366 of NFPA 70.
 2. Surface Metal Raceway: Article 386 of NFPA 70.
 3. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
 4. Consult Engineer for resolution of conflicting requirements.
- C. Special Installation Techniques:
 1. Install surface raceways only where indicated on Drawings.
 2. Install surface raceway with a minimum 2 inch radius control at bend points.
 3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.
 4. Identification: Provide labels for surface raceways and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.

3.02 PROTECTION

- A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Surface Raceways for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

Section includes furnishing and installing PVC conduit, plastic utilities duct, precast manholes, moisture sealing material, and other related work complete as indicated on the Drawings and as specified.

1.02 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean the City.

- A. American National Standards Institute, Inc. (ANSI)
 - ANSI C2 National Electrical Safety Code
- B. ASTM International (ASTM)
 - ASTM A48 Standard Specification for Gray Iron Castings
 - ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - ASTM A1011 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
 - ASTM C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
 - ASTM F512 Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
- C. National Electrical Manufacturer's Association (NEMA)
 - NEMA RN 1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit
 - NEMA TC2 Electrical Polyvinyl Chloride (PVC) Conduit
 - NEMA TC3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
 - NEMA TC 6 & 8 Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
 - NEMA TC 9 Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
- D. National Fire Protection Association (NFPA)
 - NFPA 70 National Electrical Code (NEC)
- E. State of California Administrative Code

Title 24, Part 3, CCR, California Electrical Code

- F. State of California Public Utilities Commission (Cal. PUC)
 - General Order #128 Rules for Construction of Underground Electrical Supply and Communications Systems
- G. Underwriter's Laboratories Inc. (UL) Publications
 - UL 6 Standard for Electrical Rigid Metal Conduit – Steel
 - UL 467 Grounding and Bonding Equipment
 - UL 514A Metallic Outlet Boxes
 - UL 514B Standard for Conduit, Tubing and Cable Fittings
 - UL 651 Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00, SUBMITTAL PROCEDURES.
- B. Product Data shall be submitted for the following items:
 - 1. Conduit/duct (all types)
 - 2. Precast manholes
 - 3. Sealing material for precast manholes
 - 4. Manhole frames and covers
- C. Shop Drawings shall be submitted for the following items:
 - 1. Precast Manholes: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.
 - 2. Submit structural calculations for all precast concrete items as follows:
 - a. Submit structural calculations for all loads including traffic, soil pressure and live loads.
 - b. Submit buoyancy calculations based on water table at 5 feet below grade. All products shall have a buoyancy safety factor of 1.5 minimum.
 - c. The calculations shall include a statement by the structural engineer that products are suitable for use in Seismic Zone 4 as defined by the Uniform Building Code.
- D. Certificates shall be submitted as follows:
 - 1. Material and Equipment: Provide manufacturer's statement certifying that the product supplied meets or exceeds Contract requirements.
 - a. Precast manholes and accessories.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of the General Conditions Section 01 60 00, PRODUCT REQUIREMENTS and Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL. Inspect for damage.
- B. Store and protect in accordance with manufacturer's instructions.

1.05 PROJECT CONDITIONS

- A. The Drawings are diagrammatic and shall not be scaled for exact locations. The location of existing underground utilities are based on record drawings and casual field observations. The Contractor shall use reasonable care in excavating for the installation of new underground ducts and shall be responsible for damage to existing underground utilities. Field conditions and non-interference with other utilities and trades shall determine exact locations of new underground electrical ducts.
- B. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01 70 00, EXECUTION AND CLOSEOUT REQUIREMENTS.
- B. Accurately record actual locations of exact routing of ductbank indicating plan location and depths every 50 linear feet. Measure conduit locations from permanently fixed readily discernible landmarks such as building corners, columns, manhole centerline, etc.
- C. Accurately record actual locations of each manhole.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new and of high quality to give long life and reliable operation. All equipment shall be modern in design and shall not have been in prior service except as required by factory tests. Materials and equipment shall conform to the respective Specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.

2.02 CONDUIT

- A. Rigid Metal Conduit: UL 6, hot-dip galvanized, threaded type.
- B. PVC Coated Rigid Steel Conduit Requirements: see Section 26 05 33.19, POLYVINYL CHLORIDE (PVC) COATED GALVANIZED RIGID CONDUIT.
- C. Rigid Plastic Conduit: NEMA TC2; Schedule 40 PVC.

2.03 PLASTIC DUCT

- A. Concrete Encased Plastic Utilities Duct: UL 651: Schedule 40 rigid PVC conduit.
- B. Concrete Encased Plastic Telecommunication Duct: UL 651: Schedule 40 rigid PVC conduit.

2.04 FITTINGS AND OUTLET BOXES

- A. Metal Fittings and Outlet Boxes: UL 514A and 514B. Fittings and boxes for use with steel conduit, rigid or flexible shall be cast-metal with gasketed closures.
- B. PVC Fittings and Conduit Bodies: NEMA TC3.
- C. Plastic Utility Duct Fittings: NEMA TC 6&8, TC 9, & ASTM F512.

2.05 PULL WIRE

- A. Pull wire shall be nylon having a minimum tensile strength of 200 pounds in each empty duct. Minimum 48 inches of slack shall be left at each end of pull wires. Plug spares for future use.

2.06 CABLE SUPPORTS

- A. Provide a means of supporting all cables running through electrical manholes. This shall be in the form of vertical channels cinch anchored to the manhole wall. A cantilevered support fastened to the channels shall be used to support the cable and splices. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable. A porcelain clamp shall be used to insulate and protect cables from supports. All cables smaller than 0.75-inch diameter shall be provided with some supplementary means of support such as cable tray or conduit. All exposed metal parts and fasteners shall be fabricated of stainless steel or double hot-dip galvanized steel.

2.07 PRECAST CONCRETE MANHOLES

- A. Precast concrete manholes, risers and tops shall conform to ASTM C478, except that the spacing of manhole steps or ladder rungs shall not exceed 16 inches. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete manholes. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete constructed in modular sections with tongue-and-groove joints. Walls and bottom shall be of monolithic concrete construction. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines. Provide all necessary lugs, rabbets, and brackets.
- B. Reinforcing shall be designed and constructed to accommodate the loading criteria shown in the Drawings for the various areas of the terminal.
- C. Duct Entry Provisions: Windows with plastic duct terminators and diaphragms. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking.
- D. Cable Pulling Irons: Use galvanized rod and hardware. A pulling-in iron shall be installed in the wall opposite each duct line entrance. Set pulling-in irons and other built-in items in place before depositing concrete. Provide watertight seal.
- E. Cable Rack Inserts: Minimum load rating of 800 pounds.
- F. Ladder: Steel, with top hook to engage manhole step in riser casting. Provide one ladder for each manhole.
- G. Sump Covers: ASTM A48; Class 30B gray cast iron.
- H. Riser Casting: 6 inch, with manhole step cast into frame.
- I. Frames and Covers: ASTM A48; Class 30B gray cast iron, 30 inch size, machine finished with flat bearing surfaces. The word "ELECTRIC" shall be cast in the top face of all power manhole covers. In addition, manhole identification (i.e. "EMH 1-1") shall be welded on cover.
- J. Comply with the requirements of Section 33 71 19.13, ELECTRICAL MANHOLES AND HANDHOLES.

2.08 MOISTURE SEALING MATERIAL

- A. Provide a two-part urethane foam sealant that when mixed will expand approximately 15 times in volume to form a dense, strong tough foam unit with density of 3 to 4 pounds per cubic foot. Sealant shall reach 60 percent full strength in 8 to 10 minutes after application.

2.09 GROUNDING

- A. Grounding shall conform to UL 467 and requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Underground cable installation shall conform to NFPA 70, Cal. PUC General Order #128, and all other state and local codes.

3.02 CONCRETE

- A. Concrete for electrical requirements shall be at least 3000 psi concrete with 1-inch aggregate and in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE, unless otherwise noted.

3.03 UNDERGROUND WITH CONCRETE ENCASEMENT

- A. All underground conduit shall be concrete encased. Concrete encased conduit shall be of polyvinyl chloride, Schedule 40 for power and telecommunication. Do not mix power and telecommunications conduit in one duct bank. Ducts shall not be smaller than 5 inches in diameter, unless otherwise indicated. The concrete encasement surrounding the conduit or duct bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Power and communication conduits shall be separated by a minimum of 12 inches from each other or any other underground structure, unless crossing where the separation may be reduced to 6 inches. Risers shall be PVC coated rigid galvanized steel.
- B. Ducts shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 4 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of 12'-6". Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 48 inches for ducts of 3 inches in diameter and larger.
 - 1. Join nonmetallic duct using adhesive as recommended by manufacturer. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
 - 2. Use suitable separators or chairs of high impact polystyrene installed not greater than 4 feet on center.
 - 3. The joints of the conduits shall be staggered by rows and layers so as to provide a duct line having the maximum strength.
 - 4. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs.
- C. Conduits shall terminate in end-bells at right angles with the wall, where duct lines enter manholes. As each section of a duct line is completed from manhole to manhole, a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit shall be drawn through each conduit, after which a brush having the diameter

of the duct, and having stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, and gravel; conduit plugs shall then be immediately installed.

- D. Securely anchor duct to prevent movement during concrete placement. The top of the concrete envelope shall not be less than 36 inches below grade, unless otherwise indicated on Drawings. Concrete for encasement of conduit shall be cement slurry consisting of three sacks of cements and 10 pounds of red oxide per yard of sand and in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE. SCE ducts shall be installed per SCE standards
- E. Identifying tapes shall be buried in all utility line trenches. Place one tape above the centerline of each duct bank. Refer to Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.

3.04 PRECAST MANHOLES

- A. Provide precast manholes complete with all accessories, sumps, drain facilities, and strengths as required. Identify each casting by having the manufacturer's name and address cast into an interior face or permanently attached thereto. The complete assembly, including neck, collar, frame, and cover shall accommodate the load criteria shown on the Drawings. Submit manufacturer's certificate of compliance with requirements.
- B. Install and seal precast sections in accordance with manufacturer's instructions. Install manholes plumb. Use precast neck and shaft sections to bring manhole cover to finished elevation.
- C. Attach cable racks to inserts after manhole installation is complete.
- D. Install drains in manholes and connect to 4 inch pipe terminating in crushed gravel bed.
- E. In each electric manhole, at a convenient point close to the wall, a 3/4-inch by 10-foot T-304 stainless steel clad ground rod shall be driven into the earth so that approximately 4 inches of the ground rod will extend above the manhole floor.
- F. Ground rods installed in electrical manholes shall be properly connected to the cable shielding, metallic sheath, and armor at each cable joint or splice by means of No. 6 AWG or equivalent braided tinned copper wire. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Ground wires shall be neatly and firmly attached to manhole and the amount of exposed bare wire shall be held to a minimum.
- G. Core drill or saw cut conduit entrances into existing manholes. Provide a bell end into the manhole panel. Completely seal around the conduit penetrations.
- H. Install additional cable racks in existing manholes as required for the cables being installed. Set racks and inserts on not greater than 36 inch centers.
- I. Comply with the requirements of Section 33 71 19.13, ELECTRICAL MANHOLES AND HANDHOLES.

3.05 PREPARATION FOR PULLING CONDUCTORS

- A. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

- B. Immediately after installation, plug or cap all raceway ends with water-tight and dust-tight seals until the time for pulling in conductors.
- C. For all new concrete-encased raceways, after the concrete envelope has set, pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter through each raceway. Then pull a bristle brush through each raceway to remove debris.
- D. Rod, clean and provide pull rope in all existing ducts to be used for conductor paths required in this Contract. For existing underground raceways, pull a mandrel of a diameter approximately 1/2 inch less than the raceway inside diameter through each raceway. Then pull a bristle brush through each raceway to remove debris.

3.06 EMPTY RACEWAYS

- A. Certain raceways will have no conductors pulled in as part of the Contract. Identify with tags at each end and at any intermediate pull point the origin and destination of each such empty raceway. Where a raceway has been identified with a name (number) in the Feeder Schedule, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each empty raceway. Provide a 3/8-inch nylon pull cord in each empty raceway.

3.07 GROUNDING

- A. Grounding shall be in accordance with ANSI C2. All ground wire shall be copper. Refer to Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

PART 4 - MEASUREMENT AND PAYMENT

- A. Underground Ducts and Raceways for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Power Supply".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Round sleeves.
 - 2. Rectangular sleeves.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Pourable sealants.
 - 7. Foam sealants.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ROUND SLEEVES

- A. Steel Wall Sleeves:
 - 1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. PVC Pipe Sleeves:
 - 1. General Characteristics: ASTM D1785, Schedule 40.
- C. Round, Galvanized-Steel, Sheet Metal Sleeves:
 - 1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.02 RECTANGULAR SLEEVES

- A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:
 - 1. General Characteristics:
 - a. Material: Galvanized sheet steel.

b. Minimum Metal Thickness:

- 1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.
- 2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.03 SLEEVE-SEAL SYSTEMS

- A. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- B. Options:
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

- A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.05 GROUT

- A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: 5000 psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.06 POURABLE SEALANTS

2.07 NTS

- A. Performance Criteria:
1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sustainability Characteristics:

2.08 FOAM SEALANTS

A. Performance Criteria:

1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.
2. Sustainability Characteristics:

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "JOINT SEALANTS."
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed or seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.

2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

3.03 LS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.04 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

PART 4 - MEASUREMENT AND PAYMENT

- A. Sleeves and Sleeve Seals for Electrical Raceways and Cabling as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 48
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

Section includes furnishing and installing channel support systems, restraint cables, hanger rod stiffeners, anchorage bushings and washers, and other related work complete as indicated on the Drawings and as specified herein.

1.02 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean City of Long Beach (City).

- A. American Society of Civil Engineers (ASCE)
ASCE/SEI 7-22 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- B. American Welding Society (AWS)
AWS D1.1 Structural Welding – Steel
- C. ASTM International (ASTM)
ASTM A603 Standard Specification for Metallic-Coated Steel Structural Wire Rope
ASTM E488 Standard Test Methods for Strength of Anchors in Concrete Elements
- D. National Fire Protection Association (NFPA)
NFPA 70 National Electrical Code (NEC)

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading
 - 1. Site Class: F
 - 2. Risk Category: II
 - 3. Seismic Design Category: E.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: Per ASCE 7-22 Table.
 - c. Component Amplification Factor: Per ASCE 7-22 Table.
 - 4. Design Spectral Response Acceleration at Short Periods (0.2 Second): 1.139.
 - 5. Design Spectral Response Acceleration at 1.0-Second Period: 1.304.

1.04 SUBMITTALS

- A. Submit in accordance with the provisions of Section 01 33 00, SUBMITTAL PROCEDURES.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 - 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 - 3. Field-fabricated supports.
 - 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints, include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Pre-approval and Evaluation Documentation: By an agency acceptable to Engineer, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 - 5. Welding certificates.
 - 6. Field quality-control test reports.

1.05 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1.
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to Engineer, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer currently licensed in the State of California.
- D. Comply with NFPA 70.
- E. The shop drawings must be signed and sealed by a qualified professional engineer currently licensed in the State of California.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:
1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Mason Industries.
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation.
 9. Vibration Mountings & Controls, Inc.

2.02 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following, or equal:
1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti Inc.
 5. Loos & Co.; Seismic Earthquake Division.
 6. Mason Industries.
 7. TOLCO Incorporated; a brand of NIBCO INC.
 8. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to Engineer.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A603 galvanized steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water- resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc- coated steel for interior applications and stainless steel for exterior applications.
- J. Select anchors with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.
- K. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to the Engineer.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.02 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to the Engineer providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Engineer if reinforcing steel or other embedded items are

encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.03 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.04 FIELD QUALITY CONTROL

- A. Tests and Inspections
 1. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 2. Test at least four (4) of each type and size of installed anchors and fasteners selected by the Engineer.
 3. Test to 90 percent of rated proof load of device.
 4. Measure isolator restraint clearance.
 5. Measure isolator deflection.
 6. Verify snubber minimum clearances.
 7. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved, at no additional cost to the City.
- B. Remove and replace malfunctioning units and retest as specified above, at no additional cost to the City.
- C. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

PART 4 - MEASUREMENT AND PAYMENT

- A. Vibration and Seismic Controls for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

Section includes furnishing and installing nameplates and labels, wire and cable markers, medium voltage cable tags, underground warning tape, conduit markers, warning signs, and other related work complete as indicated on the Drawings and as specified herein.

1.02 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean City of Long Beach (City).

- A. American National Standards Institute, Inc. (ANSI)
 - ANSI C2 National Electrical Safety Code
 - ANSI Z535 Safety Alerting Standards
- B. State of California Administrative Code (CAC)
 - CAC Title 8 Industrial Relations
 - CAC Title 24, Part 3 California Electrical Code
- C. National Fire Protection Association (NFPA)
 - NFPA 70 National Electrical Code (NEC)

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00, SUBMITTAL PROCEDURES and Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
- B. Product Data
 - 1. Nameplates
 - 2. Wire/cable markers
 - 3. Medium voltage cable tags
 - 4. Underground warning tape
 - 5. Conduit markers
- C. Field Samples: Provide one sample for each of the following:
 - 1. Nameplates
 - 2. Wire/cable markers
 - 3. Medium voltage cable tags

4. Underground warning tape: 24 inches long
5. Conduit markers

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.

PART 2 - PRODUCTS

2.01 NAMEPLATES

- A. Nameplate designations shall clearly state:
 1. Manufacturer's nameplate including equipment design rating of current, voltage, KVA, HP, bus bracing rating, or as applicable.
 2. Equipment nameplate designating system usage and purpose, system nominal voltage, equipment rating for KVA, amperes, HP and RPM as applicable. Panel designation and circuit number. I.D. of equipment (per mechanical Drawings designation) they feed.
 3. Contactors: Voltage, continuous current, horsepower or interrupting current, and whether "mechanically-held" or "electrically-held". Panel designation and circuit number. I.D. of load or equipment (per mechanical Drawings designation) they feed.
 4. Motors: Rated voltage, full load amperes, frequency, phases, speed, horsepower, code letter rating, time rating, type of winding, class and temperature. I.D. of motors per mechanical Drawings designation.
 5. Controllers: Voltage, current, horsepower, and trip setting of motor running overcurrent protection. Panel designation and circuit number. I.D. of load or equipment (per mechanical Drawings designation) they feed.
 6. Distribution Boards / Panelboards: Distribution boards / panel I.D. per electrical Drawings, I.D. of feeder distribution board & circuit number and all branch circuit load description.
 7. Receptacles and lighting switches (wiring devices): Panel designation and circuit number.
- B. Nameplates shall be melamine plastic, 0.125-inch-thick, black with white center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering into the black core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches except that wiring device nameplates shall be 0.5 inch by 1.5 inch. Lettering shall be normal block style unless otherwise noted.
- C. Letter Size
 1. Use 0.25 inch letters for identifying individual equipment and loads.
 2. Use 0.50 inch for identifying grouped equipment and loads.

2.02 WIRE MARKERS

- A. Description: Heat shrinkable, flame-retarded, crosslinked polyolefin wire marker. Wire tags shall have a dielectric strength of 500 V/mil minimum and a temperature range from -30 degrees Celsius to 105 degrees Celsius. Thermoplastic or wraparound tags are not acceptable. All tags shall be printed using a 9 or 24 pin dot matrix printer. Raychem ShrinkMark™, Brady Permasleeve or equal.
- B. Legend

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.
2. Control Circuits: Control wire number indicated on schematic or interconnection diagrams on shop drawings.

2.03 UNDERGROUND WARNING TAPE

- A. Underground warning tape shall be 6-inches-wide x 0.004-inch polyethylene plastic with a metallic core. The tape shall be of a bright color contrast with soil, with identifying printing on one side. The imprint shall read "Caution (type of utility) Line Buried Below". The identifying lettering shall be repeated continuously the full length of the tape. Refer to Section 33 05 26, UTILITY IDENTIFICATION.

2.04 CONDUIT MARKERS

- A. ANSI Z535
 1. Provide Pressure-sensitive, adhesive-backed vinyl markers with fade-proof ultraviolet inhibitors, black characters on orange background. Size: 2.25-inch x 9-inch marker with 1.5-inch-high letters. Marker shall read "4160 VOLTS" depending on circuit phase-to-phase voltage. Carlton Industries type EM-1, Seton Code Electrical Markers style AA, Brady B-500 series or equal.
 2. Provide 12-inch x 12-inch x 6-inch thick concrete marker with "Conduits Buried Below" engraved on the visible surface. Top of marker shall be at finished grade. Marker shall be placed directly above the stub end of all stubbed out buried conduits. If conduits are grouped less than 1 foot from center to center, a single marker may be used. See Electrical Standard Plan E-70 "Conduit Stub Detail-Section".

2.05 MV CABLE TAGS

- A. Identification tags shall be engraved laminated plastic connected to the cable by means of self-locking cable ties. Tags shall contain the following information:
 1. Feeder number (i.e., F1A-T13)
 2. Cable start point.
 3. Cable destination.
 4. Cable quantity, size, insulation and voltage.
 5. Date installed (if new).
- B. Cable tags shall be melamine plastic, 0.125-inch-thick x 2.5 inches x 5.0 inches, black with white center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering into the black core. Lettering shall be 0.25-inch-high normal block style unless otherwise noted.

2.06 WARNING SIGNS

- A. ANSI Z535
 1. Warning signs shall be minimum 18 gauge steel white porcelain enamel finish with red lettering. Lettering to read "DANGER - HIGH VOLTAGE" with "DANGER" in 1-1/2-inch letters and "HIGH VOLTAGE" in 1-inch letters. New warning signs shall be provided on door/gate or immediately above door of all electrical equipment rooms, vaults, closets or outdoor substations containing equipment energized above 150 volts to ground, except where such spaces are accessible from public areas.

2. Warning designations in 1-inch red letters shall be painted by stencil or pre-printed adhesive on each new pull box or cabinet stating "DANGER" and giving voltage of enclosed conductors such as "DANGER - 12,000 VOLTS", for all systems over 150 volts to ground.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.
- B. Coordinate installation of nameplates, markers and warning signs with the sequence of painting. Refer to Section 09 90 00, PAINTING AND COATING.

3.02 NAMEPLATES

- A. Provide laminated plastic nameplates for all electrical equipment and devices including, but not limited to, the following:
 1. Enclosures for switchgear, medium voltage controllers, transformers, low voltage switchgear, distribution board, motor control centers, variable frequency drives, panels, panelboards, busway, pull boxes, junction boxes, cabinets and motors.
 2. Enclosures for all separately enclosed devices including but not limited to disconnect switches, circuit breakers, contactors, time switches, control stations and relays.
 3. All receptacles and lighting switches.
 4. Special systems such as but not limited to telephone, warning and signal systems. Identification shall be at each equipment rack, terminal cabinet, control panel, annunciator, and pull box.
 5. Devices mounted within and part of an equipment including circuit breakers, switches, control devices, control transformers, relays, indication devices and instruments.
- B. Mounting: Provide number, location, and letter designation of nameplates as indicated. Install nameplate parallel to equipment lines. Fasten nameplates to enclosures with a minimum of two sheet-metal screws or two rivets. Fasten nameplates to device plates with suitable adhesive. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

3.03 WIRE MARKERS

- A. Provide markers for each conductor at panelboard gutters, pull boxes, junction boxes, outlet boxes, and each load connection.

3.04 UNDERGROUND WARNING TAPE

- A. Identifying tapes shall be buried in all utility line trenches. Each trench shall have one tape above the centerline of each duct. In non-paved areas, the tape shall be located approximately 8 inches below the final finish grade. In areas where paving is to be installed, the tape shall be placed in the trench 1 foot above utility.

3.05 CONDUIT MARKERS

- A. Provide markers on all exposed conduit for circuits greater than 600 volts. Provide markers at lengths not greater than 20 feet on center.

3.06 MV CABLE TAGS

- A. All new cables installed shall be identified at each end and at all accessible points in between (such as manholes, pull boxes, switchgear, etc.). Identify existing cables that are being re-routed or changed with new tags. Modification of existing tags shall not be acceptable.

3.07 WARNING SIGN MOUNTING

- A. Signs shall be permanently mounted with cadmium plated steel screws or nickel-plated brass bolts.

PART 4 - MEASUREMENT AND PAYMENT

- A. Identification for Electrical Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 05 73
OVERCURRENT PROTECTION DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.01 SUMMARY

- A. Contractor shall be responsible for obtaining information about existing electrical equipment and existing electrical power system studies, if available. Field work will be required to verify actual installation from point of Southern California Edison (SCE) connection to first piece of new electrical equipment connected to the existing electrical system.
- B. Analysis shall include data collection, system modeling, and model verification, protective device coordination study, short circuit study, fault and device duty evaluation, load flow study and arc flash hazard assessment. Project deliverables shall include a detailed report of the findings and recommendations.
- C. Contractor will adjust all relays and adjustable trip circuit breakers to settings determined by the "as-built" power system study.
- D. Contractor shall attach new arc flash labels to new and existing electrical equipment as required by National Fire Protection Agency (NFPA) 70E.

1.02 DEFINITIONS

- A. AFIE: Arc Flash Incident Energy
- B. TCC: Time-Current Characteristics Curves
- C. SCE: Southern California Edison

1.03 SCOPE OF WORK

- 1. Request available short circuit current and X/R ratio from SCE at SCE point of connection. Visit all substations and switchboards between the SCE point of connection and the last piece of equipment that requires arc flash label. Record the settings of all relays and adjustable trip circuit breakers 400A or above between SCE feed point and the last piece of equipment requiring arc flash label. Incorporate the recorded information in all electrical system studies.
- 2. If the above data is not available, state the reason that the information could not be located and the method used to determine the assumed settings.

1.04 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean City of Long Beach (City).

- A. American National Standards Institute (ANSI)
 - ANSI C57.12.01 General Requirements for Dry-Type Distribution and Power Transformers
 - ANSI C37.13 Low-Voltage AC Power Circuit Breakers Used in Enclosures

- | | | |
|----|--|--|
| | ANSI C37.010 | Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on a Symmetrical Current Basis |
| | ANSI C37.41 | Design Tests for High-Voltage (>1000 V) Fuses and Accessories |
| B. | Institute of Electrical and Electronics Engineers (IEEE) | |
| | IEEE C2 | National Electric Safety Code |
| | IEEE 141 | Recommended Practice for Electric Power Distribution for Industrial Plants |
| | IEEE 241 | Recommended Practice for Electric Power Systems in Commercial Buildings |
| | IEEE 242 | Protection and Coordination of Industrial and Commercial Power Systems |
| | IEEE 399 | Recommended Practice for Industrial and Commercial Power Systems Analysis |
| | IEEE 1015 | Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial And Commercial Power Systems |
| | IEEE 1584 | Guide for Performing Arc Flash Hazard Calculations |
| C. | National Electrical Manufacturers Association (NEMA) | |
| | NEMA MG 1 | Motors and Generators |
| D. | National Fire and Protection Association (NFPA) | |
| | NFPA 70 | National Electrical Code (NEC) |
| | NFPA 70E | Standard for Electrical Safety in the Workplace |

1.05 SUBMITTALS

- A. Submit under provisions of Section 01 33 00, SUBMITTAL PROCEDURES.
- B. One copy of all completed electrical power system studies shall be bound and submitted to Engineer.
- C. Contractor shall submit a complete electrical power system study, prepared, signed and stamped by a registered electrical engineer in the State of California. Include in the submittal a table containing settings of all relays and adjustable trip circuit breakers rated over 400A. Approval from the Engineer is required prior to setting all relays and adjustable trip circuit breakers, and prior to energization of equipment.
- D. Contractor shall perform an electrical power system study to determine the final settings of the relays and adjustable trip circuit breakers over 400A per the final "as-built" installation. The study shall be included in the switchgear O&M Manual. This submittal shall contain the following:
 1. Complete input data report, including computer generated protected device settings report.
 2. Load flow study.
 3. Load flow, short circuit and arc flash analyzer reports in MS Excel format.
 - a. Short circuit and arc flash result analyzer reports shall indicate worst case scenario conditions and associated results.
 4. Short circuit study, device duty and equipment evaluation reports.
 5. Coordination study report including computer generated time-current characteristic curves (TCC).

6. Arc flash hazard assessment report and personal protective equipment label.
7. Electronic copy of computer software (project) model including update to existing model if available in ETAP.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 ELECTRICAL POWER SYSTEM STUDIES

- A. A one-line diagram shall be provided with all equipment and material that is part of the electrical system studies. The device numbers and names shall match those shown on the existing 'as-built' drawings or Contract Drawings for new equipment. The following data shall be collected for the study:
 1. Product data for overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Generator kilovolt amperes, size, voltage, and source impedance.
 - c. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - d. Motor horsepower and code letter designation according to NEMA MG 1.
 3. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations such as cranes, including starting inrush currents, regeneration and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective device.
 - e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - g. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.02 SHORT CIRCUIT STUDY

- A. Short circuit study will be performed to ensure that all electrical equipment and protective devices can withstand the maximum available short circuit current.
- B. Calculate the maximum available short circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit.

Calculate momentary and interrupting duties on the basis of maximum available fault current at each of the following:

1. Switchgear, switchboard, busways, bus duct, motor control centers, unit substations, transformers, panelboards, automatic transfer switches and other significant locations throughout the system.
- C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- D. Protective Device Time-Current Coordination Analysis
1. The time-current coordination analysis shall be performed with the aid of computer software program, ETAP, and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
 2. A sufficient number of computer generated TCCs log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of connected overcurrent devices and other pertinent system parameters.
 3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
 4. When equipment is directly connected to SCE, Contractor shall work with SCE and ensure that all relay settings or adjustable trip breaker coordinate with SCE.
 5. The study shall include a separate table containing the suggested device setting of all relays and adjustable overcurrent protective devices; indicate the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
 6. A computer generated system one-line diagram shall be provided that clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus. These identifications must be in accordance with the Contract Documents and identical to what is shown in the Contract Documents.
 7. A discussion section that evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
- E. Significant deficiencies in protection and/or coordination shall be called to the attention of the Engineer and recommendations made for improvements as soon as they are identified.

3.03 LOAD FLOW STUDY

- A. Load flow study shall be performed to evaluate the system's capability to adequately supply the connected load and prevent overloading of equipment.
- B. Compare equipment (transformers, cables, breakers, fuses) operating values against manufacturer's specified maximum capability ratings whenever available.
- C. Provide a computer generated alert view list/report that lists all equipment that is overloaded.

- D. Voltage drop calculations shall be performed on all circuits to determine the worst case voltage drop. Feeder voltage drop shall be limited to 3% and branch circuit shall be less than 2%. The voltage drop results shall be shown individually on the single line diagram.
- E. Provide a computer generated load flow analysis report that provides a summarized comparison of power flow results between the different scenarios being evaluated.

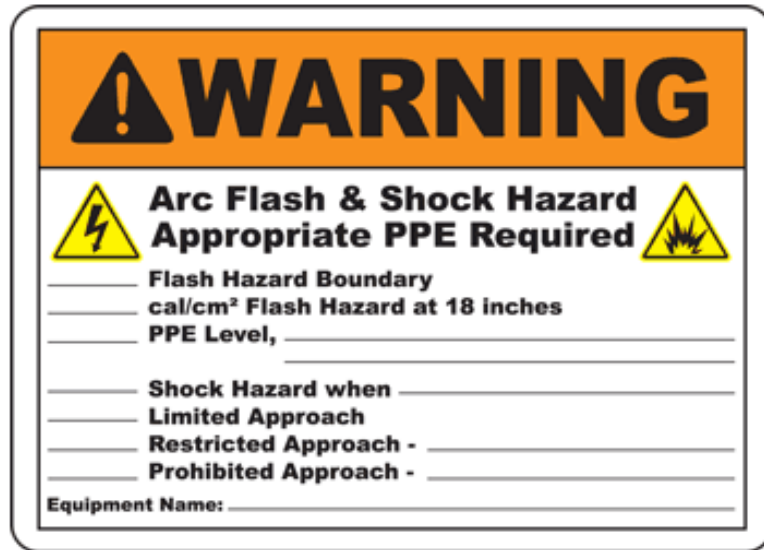
3.04 ARC FLASH HAZARD ANALYSIS

- A. All requirements shall be from the latest edition of the referenced code or standard. Arc flash warning labels shall be provided on all electrical equipment as required by the NEC, IEEE-1584, IEEE C2 and NFPA 70E. In case of any conflict, the more stringent requirement shall be used.
 - 1. The arc flash hazard analysis shall be performed with the aid of a digital computer in order to calculate arc flash incident energy (AFIE) levels and arc flash protection boundary distances.
 - 2. The arc flash hazard analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
 - 3. Results of the arc flash hazard analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
 - 4. The arc flash hazard analysis shall be performed by a professional electrical engineer registered in the State of California.
 - 5. The arc flash hazard analysis shall be performed in compliance with IEEE 1584.
 - 6. The arc flash hazard analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.
 - 7. The arc flash hazard analysis shall report incident energy values based on the existing incident energy values at all buses within the scope of the study in addition to incident energy values based on the recommended overcurrent device setting changes.
- B. Calculations must be submitted for each piece of equipment shall be performed to determine the following minimum information required in an arc flash hazard protection analysis:
 - 1. Hazard Risk Category (HRC): A general classification of hazard involved in performing specified tasks. Typically ranges from 0 to 4. The NFPA provides a recommended list of personal protective equipment (PPE) for each HRC in Table 130.7 of NFPA 70E.
 - 2. Incident Energy (cal/cm²) at 18 inches: This is the energy per unit area for a potential arc flash 18 inches from the source of the arc.
 - 3. Arc Flash Boundary: This is the distance from the arc flash source for which a person is likely to receive a second degree burn. Second degree burns typically occur at an energy level of 1.2 cal/cm².
 - 4. Shock Hazard Protection Information: The minimum information required in a shock hazard protection analysis are:
 - a. Limited Approach Boundary: This boundary may only be crossed by a qualified person, or an unqualified person wearing appropriate PPE and accompanied by a qualified person.

- b. Restricted Approach Boundary: This boundary may only be crossed by authorized management using adequate shock prevention equipment and techniques.
- c. Prohibited Approach Boundary: This boundary may only be crossed by a qualified person that has the same level of protection required for direct contact with live parts.
- d. List of PPE: Provide a list of PPE to be worn when working on energized electrical equipment.
- e. A copy of the calculations and label shall be submitted for arc flash labels.

EXAMPLE OF LABEL TO BE USED

(3.5 inch x 5 inch thermal transfer type label of high adhesion polyester)



EXAMPLE OF INFORMATION PROVIDED IN THE FINAL ANALYSIS

	BUS NAME		
	100 T-920A	101 PNL PCA	102 TD-304
Protective Device Name	004 Dual	101 PCA Main	101 PCA - 10
KV	0.48	0.48	0.48
Bus Bolted Fault (kA)	14.81	14031	7.51
Protective Device Bolted Fault (kA)	13.65	13.15	7.51
Arcing Fault (kA)	8.45	8.19	5.14
Time / Delay Trip (sec)	1.451	0.04	0.0017
Breaker Opening Time (sec)	0	0	0
GND	Yes	Yes	Yes
Equipment Type	Panel	Panel	Panel
GAP (mm)	25	25	25
Arc Flash Boundary (in)	145	18	7
Working Distance (in)	18	18	18
Incident Energy (cal/cm²)	36.8	1.17	0.27
Hazard / Risk Category Number	4	0	0

5. A discussion section that evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations to lower available arc fault currents.

3.05 FINAL REQUIREMENTS

- A. The final study performed by the Contractor shall be generated based on the final electrical equipment submittals and final pulled conductor lengths.
- B. Based on the findings of the final report, Contractor shall have a third party contractor set the relays and circuit breakers prior to final acceptance and functional testing.
- C. The final report will be reviewed by, signed and stamped by a professional electrical engineer registered in the State of California.

PART 4 - MEASUREMENT AND PAYMENT

- A. Overcurrent Protection Device Coordination Study as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Switchbox-mounted occupancy sensors.
 - 2. Conductors and cables.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Switchbox-mounted occupancy sensors.
 - 2. Conductors and cables.
- B. Shop Drawings:
 - 1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - 2. Interconnection diagrams showing field-installed wiring.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Field quality-control reports.

1.03 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranties.

1.04 WARRANTY

- A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 - 2. Extended Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nWSX series or comparable product by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Leviton Manufacturing Co., Inc.
- B. General Requirements for Sensors: Low-voltage, automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired low-voltage connection.
 - 1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application, and must comply with California Title 24.
 - 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 4. Separate power pack.
 - 5. Programmable "off" time-delay selector at up to 30 minutes.
 - 6. Field Adjustable Control Mode:
 - a. Auto On/Auto Off (Fully Automatic).
 - b. Manual On (initial state) to Override On (with expiration timer).
 - c. Auto On (initial state) to Override On (with expiration timer).
 - d. Manual On / Automatic Off (Semi-Automatic).
 - e. Manual On (initial state) to Fully Automatic.
 - f. Predictive Off Switch (returns zone to auto-on unless person remained in room after an off-switch press).
 - 7. Maximum Humidity: 90 percent, non-condensing.
- C. Wall-Switch Sensor Tag WS1:
 - 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2025 sq. ft.
 - 2. Sensing Technology: Dual technology - PIR and microphonic.
 - 3. Switch Type: Raise/lower dimmer controls.
 - 4. Capable of controlling load in three-way application.
 - 5. Input Voltage: 120 V to 277 V (ac).
 - 6. Output Rating: 120 V(ac), 800 W, 6.7 A tungsten, standard ballast, electronic ballast or ½ hp.
 - 7. Low-Voltage Output Rating: 0 to 10 V(dc), 50 mA.
 - 8. Ambient-Light Override: Programmable, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lx). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 - 9. Operating Temperature: 14 to 122 deg F (minus 10 to plus 50 deg C).
 - 10. Color: White.
 - 11. Faceplate: Color matched to switch.
- D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft..
2. Sensing Technology: Dual technology – PIR and microphonic.
3. Switch Type: Raise/lower dimmer controls.
4. Capable of controlling load in three-way application.
5. Voltage: 15 to 24 V(dc), 3 mA, Class 2.
6. Ambient-Light Override: Programmable, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Operating Temperature: 32 to 122 deg F (Zero to 50 deg C).
8. Color: White.
9. Faceplate: Color matched to switch.

E. Power Pack:

1. Basis of Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP20 series or comparable product by sensor manufacturer.
2. Dry contacts Rating: 120 to 277 V(ac), 16 A tungsten, standard ballast electronic ballast and ½ hp at 120 V(ac) with integrated overcurrent protection for load side faults.
3. LED status lights to indicate load status.
4. Plenum rated.
5. Relay Type: Latching.
6. Class 2 Power Supply: 15 V(dc), 40 mA power source for sensors.
7. Operating Temperature: 14 to 122 deg F (minus 10 to plus 50 deg C).
8. Maximum Humidity: 90 percent, non-condensing.
9. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.

2.02 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.03 INSTALLATION OF CONTACTORS

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.04 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.05 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS.
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.06 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:
 1. Engage factory-authorized service representative to support field tests and inspections.

3.07 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit City's operations.
 2. For daylighting controls, adjust set points and deadband controls to suit City's operations.
 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.08 MAINTENANCE

- A. Software and Firmware Service Agreement:
 1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for two years.
 2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
 - a. Upgrade Notice: No fewer than 30 days to allow City to schedule and access the system and to upgrade computer equipment if necessary.
 3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

PART 4 - MEASUREMENT AND PAYMENT

- A. Lighting Control Devices as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 22 13
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

Section includes furnishing and installing dry type, two-winding transformers and other related work complete as indicated on the Drawings and as specified.

1.02 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean City of Long Beach (City).

- A. Institute of Electrical and Electronics Engineers (IEEE)
 - IEEE C2 National Electrical Safety Code
 - IEEE C57.12.01 General Requirements for Dry-Type Distribution and Power Transformers
 - IEEE C57.12.91 Test Code for Dry-Type Distribution and Power Transformers
 - IEEE C57.94 Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers
- B. National Electrical Contractors Association (NECA)
Standard of Installation
- C. National Electrical Manufacturer's Association (NEMA)
 - NEMA ST 20 Dry Type Transformers for General Applications
 - NEMA TR 1 Transformers, Step Voltage Regulators and Reactors
- D. National Fire Protection Association (NFPA)
NFPA 70 National Electrical Code (NEC)

1.03 SUBMITTALS

Submit under provisions of Section 01 33 00, SUBMITTAL PROCEDURES and Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.

- A. Manufacturer's Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, rated winding temperature rise, nameplate legends and anchor calculations.
- B. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years documented experience.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with NECA Standard of Installation.
- B. Maintain one copy of each document on site.

1.06 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect, and handle products to site under provisions of Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
- B. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- C. Accept transformers on site. Inspect for damage.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new and of high quality to give long life and reliable operation. All equipment shall be modern in design and shall not have been in prior service except as required by factory tests.

2.02 TWO-WINDING TRANSFORMERS

- A. Manufacturers
 - 1. Square D Company., or equal.
- B. Description: NEMA ST 20, ANSI C57.12.01, 60 hertz, factory-assembled, distribution, air cooled, dry type transformers, with copper windings and ratings as indicated.
- C. Transformer shall have 220-degree Celsius insulation with a winding temperature rise not exceeding 80 degrees Celsius under full load in a maximum ambient of 40 degrees Celsius. Mini Power Center (MPC) type transformer shall have a 180-degree Celsius insulation with a winding temperature rise not exceeding 115-degree Celsius under full load in a maximum ambient of 40 degrees Celsius.

- D. Case temperature: Do not exceed 35 degrees Celsius rise above ambient at warmest point.
- E. Winding Taps: NEMA ST 20. Equip with NEMA standard taps. If taps are not standard, equip transformer with two 2-1/2% FCAN and two 2-1/2% FCBN.
- F. Sound Levels: NEMA TR 1. Maximum sound levels shall be an average of 3 dB lower than NEMA TR 1 standard sound levels for the transformer size indicated.
- G. Basic Impulse Level: 10 kV.
- H. Minimum impedances, unless otherwise indicated, shall be as follows:
 - 1. 75 kVA and smaller: 3.0 percent.
 - 2. Larger than 75 kVA: 4.5 percent.
- I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap. Where neutral connection is indicated, attach to bolt and lug inside enclosure and extend bolt through enclosure to permit external ground connection.
- J. Mounting: Suitable for wall, trapeze or floor mounting as indicated.
- K. Copper Coil Conductors: Continuous windings with terminations brazed or welded. Brace and locate windings, terminals, and connections for maximum short circuit stresses to prevent accidental grounding of windings and connections.
- L. Enclosure: NEMA ST 20, Type 1 unless otherwise noted. Provide lifting eyes or brackets. Construct enclosures of heavy gage sheet steel, primed inside and out with a zinc chromate or iron oxide rust-inhibiting primer. Finish with manufacturer's standard color enamel. Overall dimensions shall not exceed the limits indicated or the space available.
- M. Isolate core and coil from enclosure using vibration-dampeners.
- N. Efficiency: Transformer shall have an efficiency rating of 97 percent or more.
- O. Nameplates
 - 1. Conspicuously display on each transformer enclosure a metal nameplate with stamped or engraved markings showing: connection, including taps; kVA; phases; frequency; primary and secondary voltages; percent R, X and Z; temperature rise; insulation class; BIL rating; no-load and full-load losses; and sound level rating.
 - 2. Provide laminated plastic nameplate as specified in Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS, identifying transformer designation in 1/2-inch-high letters.

2.03 SOURCE QUALITY CONTROL

- A. Provide testing of transformers as specified in Section 26 08 13, ELECTRICAL ACCEPTANCE TESTING.
- B. Provide production testing of each unit in accordance with NEMA ST 20 and IEEE C57.12.91. The following tests shall be performed at the factory:
 - 1. Applied voltage test (to each winding and from each winding to ground).
 - 2. Induced voltage test - 2 times normal voltage.
 - 3. Ratio, polarity and sound level.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Transformer installation shall conform to NFPA 70, IEEE C57.94, and all other state and local codes, and to requirements specified herein.
- B. Contractor shall make all field verifications necessary to ensure proper installation of all equipment as supplied.
- C. Contractor is responsible for coordinating timely equipment delivery.
- D. Install products in accordance with manufacturer's instructions.
- E. Set transformer plumb and level.
- F. Make conduit connections to side panel of enclosure. Provide seismic restraints.

3.02 GROUNDING

- A. Grounding shall be in accordance with IEEE C2. All ground wire shall be copper. Refer to Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

3.03 NAMEPLATES

- A. Provide as specified in Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.

3.04 FIELD TESTS

- A. Refer to Section 26 08 13, ELECTRICAL ACCEPTANCE TESTING for additional requirements. As an exception to requirements that may be stated elsewhere in the Contract, the Engineer shall be given a minimum of five (5) working days' notice prior to each test. All testing shall comply with IEEE C57.12.91.
- B. Field inspection and testing will be performed under provisions of Section 26 08 13, ELECTRICAL ACCEPTANCE TESTING.
- C. Check for damage and tight connections prior to energizing transformer.
- D. Measure the secondary voltage of the new transformer and reset the primary taps if necessary.
- E. Test information shall be supplied to the Engineer within 10 days after completion of testing.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Electrical Distribution*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

Section includes furnishing and installing panelboards and other related work complete as indicated on the Drawings and as specified.

1.02 REFERENCE STANDARDS

The following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Perform all work and install all materials and equipment in full accordance with the latest publications. When interpreting the following consider advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references to "authority having jurisdiction," or other words of similar meaning, to mean City of Long Beach (City).

- A. National Electrical Contractors Association (NECA)
Standard of Installation
- B. National Electrical Manufacturer's Association (NEMA)
 - NEMA AB1 Molded-Case Circuit Breakers, Molded Case Switches, and
Circuit-Breaker Enclosures
 - NEMA ICS2 Controllers, Contactors and Overload Relays Rated 600 V
 - NEMA PB1 Panelboards
 - NEMA PB1.1 General Instructions for Proper Installation, Operation, and
Maintenance of Panelboards Rated 600 Volts or Less
- C. National Fire Protection Association (NFPA)
70 National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL)
 - UL 50 Enclosures for Electrical Equipment, Non-Environmental
Considerations
 - UL 67 Panelboards
 - UL 869 Reference Standard for Service Equipment

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00, SUBMITTAL PROCEDURES and Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
- B. Product Data: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

- D. Maintenance materials as specified.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years documented experience.

1.05 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Section 26 01 00.13, OPERATION AND MAINTENANCE MANUALS.
- B. Provide two of each panelboard key per panelboard.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall conform to the respective specifications and standards and to the Specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels. Items of a similar nature shall be of the same type and manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

- A. Square D., or approved equal.

2.03 PANELBOARDS

- A. Panelboards: UL 50, UL 67, NEMA PB1, circuit breaker type, size and number of breakers as indicated.
- B. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard. Where isolated ground bus is required, a ground bus shall be mounted on insulators isolated from the enclosure.
- C. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 240 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated on the Drawings.
- D. Molded Case Circuit Breakers: NEMA AB1, bolt-on type, ambient compensated, thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers. Where main breaker is shown as non-automatic, it shall be equipped with high magnetic trip with same interrupting capacity as all branch circuit breakers.
- E. Enclosure: NEMA PB1, Type 1 for indoor installation and NEMA Type 3R for outdoor installation. NEMA 3R enclosures shall have all covers and doors thoroughly cleaned using phosphate wash and apply a zinc rich corrosion resistant primer and then a polyester powder coat suitable for marine environment. Exterior surfaces shall be given final finish coats of ANSI 61 light grey air-dried acrylic enamel, covered with a clear polyurethane top coat.
- F. Cabinet Box: 6 inches deep, 20 inches wide.
- G. Cabinet Front: Flush or surface cabinet front as indicated with concealed trim clamps, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Electrical installation shall conform to requirements of NFPA 70, state and local codes, and to requirements specified herein.
- B. Install panelboards in accordance with NEMA PB1.1 and NECA Standard of Installation.
- C. Align and level panelboards and securely fasten to the building. Do not use connecting conduits to support the panelboards. Install trim plumb and square.
- D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard affected by work under this Contract. Revise directory to reflect circuiting changes on existing panelboards.
- G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: 5 empty, 1-inch. Identify each as "SPARE".

3.02 FIELD TESTS

- A. Field inspection and testing will be performed under provisions of Section 26 08 13, ELECTRICAL ACCEPTANCE TESTING.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.
- C. Check current rating of all circuit breakers. To each pole of the circuit breakers apply current 3 times its rating, recording currents and breaker trip times. Apply rapidly increasing currents and record the value that consistently causes instantaneous tripping of the breaker. Compare these recorded times with manufacturer's time current curves.
- D. Perform megger and hi-pot test on each pole.
- E. All discrepancies found by the Contractor shall be brought to the attention of the Engineer.
- F. All testing shall be performed in the presence of the Engineer. The Contractor shall notify the Engineer when the equipment is installed and ready for testing.

3.03 NAMEPLATES

- A. Provide nameplates for all panelboard enclosures. Nameplate designations shall clearly state:
 - 1. Manufacturer's nameplate including equipment design rating of current, voltage, bus bracing rating, or as applicable.
 - 2. Equipment nameplate designating system usage and purpose, system nominal voltage, equipment rating for amperes, panel designation and circuit number, and identification (ID) of equipment.
 - 3. Distribution boards/panelboards: Distribution boards/panel ID per electrical Drawings, and ID of feeder distribution board and circuit number and all branch-circuit load descriptions.
- B. Nameplates shall be melamine plastic, 0.125-inch-thick, black with white center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering into the

white core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches, except that wiring device nameplates shall be 0.5 inch by 1.5 inches. Lettering shall be normal block style, unless otherwise noted.

C. Letter Size

1. Use 0.25-inch letters for identifying individual equipment and loads.
2. Use 0.50-inch letters for identifying grouped equipment and loads.

D. Mounting: Provide number, location, and letter designation of nameplates as indicated. Install nameplate parallel to equipment lines. Nameplates shall be permanently fastened to enclosures with a minimum of two stainless steel sheet-metal screws or two stainless steel rivets or other approved means, suitable for a marine environment. High strength, long curing (12 hour or longer) epoxy shall be acceptable where screws or rivets would provide water ingress to an enclosure

PART 4 - MEASUREMENT AND PAYMENT

- A. Panelboards as specified herein shall be included in the measurement and payment for "Electrical Power Supply".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

1.02 ACTION SUBMITTALS

A. Product Data:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

B. Field quality-control reports.

1.03 CLOSEOUT SUBMITTALS

A. Sustainable Design Closeout Documentation

1.04 WARRANTY FOR DEVICES

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
1. Initial Extended Warranty Period: One year from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.01 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN WMUZ and UL 20.

3. Options:

- a. Device Color: Ivory White.
- b. Configuration:
 - 1) General-duty, 120-277 V, 20 A, single pole double pole three way four way as indicated on drawings.
 - 2) Extra-heavy-duty, 120-277 V, 30 A, single pole double pole three way as indicated on drawings.

4. Accessories:

- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Rocker Switch:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN WMUZ and UL 20.

3. Options:

- a. Device Color: Ivory White.
- b. Configuration:
 - 1) 120-277 V, 15 A, as indicated on drawings.
 - 2) 120-277 V, 20 A, as indicated on drawings.

4. Accessories:

- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Type I Dimmer Switch:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN EOYX and UL 1472 Type I dimmer.

3. Options:

- a. Device Color: White.
- b. Switch Style: By manufacturer.
- c. Dimming Control Style: By manufacturer.

4. Accessories:

- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.02 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN RTRT and UL 498.

3. Options:

- a. Device Color: White.
- b. Configuration:
 - 1) Heavy-duty, NEMA 5-20R.
 - 2) Heavy-duty, NEMA 6-20R.

4. Accessories:

- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.03 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

- A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
 - 3. Options:
 - a. Device Color: White.
 - b. Configuration: Heavy-duty, NEMA 5-20R.
 - 4. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.04 LOCKING RECEPTACLES

- A. NEMA, 125 V, Locking Receptacle:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 3. Options:
 - a. Device Color: Black with yellow voltage indication on face.
 - b. Configuration: 2 pole, 3 wire, grounding, type to be as stated on drawings.
- B. NEMA, 125 V, Isolated Ground Locking Receptacle:
 - 1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 3. Options:
 - a. Device Color: Black with yellow voltage indication on face.
 - b. Configuration: 2 pole, 3 wire, grounding, type to be as stated on drawings.
- C. NEMA, 250 V, Locking Receptacle:
- 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 3. Options:
 - a. Device Color: Black with blue voltage indication on face.
 - b. Configuration:
 - 1) 2 pole, 3 wire, grounding, type to be as stated on drawings.
 - 2) 3 pole, 4 wire, grounding, type to be as stated on drawings.
 - 3) 4 pole, 4 wire, non-grounding, type to be as stated on drawings.
 - 4) 4 pole, 5 wire, grounding, type to be as stated on drawings.
- D. NEMA, 250 V, Isolated Ground Locking Receptacle:
- 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 3. Options:
 - a. Device Color: Black with blue voltage indication on face.
 - b. Configuration:
 - 1) 2 pole, 3 wire, grounding, type to be as stated on drawings.
 - 2) 3 pole, 4 wire, grounding, type to be as stated on drawings.
 - 3) 4 pole, 5 wire, grounding, type to be as stated on drawings.

2.05 CONNECTORS, CORDS, AND PLUGS

A. Outdoor-Use, Watertight, Sealed Cord Connector:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN AXUT and UL 498.

3. Options:

- a. Configuration:

- 1) NEMA 5-20.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receptacles:

- 1. Verify that receptacles to be procured and installed for City-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels:

- 1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
- 2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
- 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SELECTION OF GFCI RECEPTACLES

- A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.03 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.

B. Reference Standards:

- 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Engineer for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.04 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
 - a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
4. Consult the Engineer for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.05 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Engineer for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.06 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

- A. Comply with manufacturer's instructions.

3.07 FIELD QUALITY CONTROL OF SWITCHES

- A. Field tests and inspections.
- B. Tests and Inspections:
 - 1. Perform tests and inspections in accordance with manufacturers' instructions.
- C. Nonconforming Work:
 - 1. Unit will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Assemble and submit test and inspection reports.

3.08 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- A. Tests and Inspections:
 - 1. Insert and remove test plug to verify that device is securely mounted.
 - 2. Verify polarity of hot and neutral pins.
 - 3. Measure line voltage.
- B. Nonconforming Work:
 - 1. Device will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- C. Assemble and submit test and inspection reports.

3.09 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

- A. Field tests and inspections.
- B. Tests and Inspections:
 - 1. Insert and remove test plug to verify that device is securely mounted.
 - 2. Verify polarity of hot and neutral pins.
 - 3. Measure line voltage.
- C. Nonconforming Work:
 - 1. Device will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Assemble and submit test and inspection reports.

3.10 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by City.

B. Cord Reels and Fittings:

1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by City.

C. Connectors, Cords, and Plugs:

1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by City.

PART 4 - MEASUREMENT AND PAYMENT

- A. Wiring Devices as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Enclosures.

1.02 DEFINITIONS

- A. GFEP: Ground-fault circuit-interrupter for equipment protection.
- B. GFLS: Ground-fault circuit-interrupter for life safety.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 2. Enclosure types and details for types other than UL 50E, Type 1.
 - 3. Current and voltage ratings.
 - 4. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.
- C. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.04 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.06 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty: Manufacturer warrants that enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.02 FUSIBLE SWITCHES

- A. Type HD, Heavy Duty:
 - 1. Double throw.
 - 2. Three pole.
 - 3. 600 V(ac).
 - 4. 200 A and smaller.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

2.03 NONFUSIBLE SWITCHES

- A. Type HD, Heavy Duty, Three Pole, Double Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

2.04 MOLDED-CASE CIRCUIT BREAKERS

- A. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.
- B. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.
- C. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers type to be as stated in load calculations or on drawings. Combinations for series connected interrupting ratings must be listed by UL as recognized component combinations. Series rated combination used must be marked on end-use equipment along with statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."
- D. MCCBs must be equipped with device for locking in isolated position.

- E. Lugs must be suitable for 75 deg C rated wire.
- F. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.
- G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- H. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- I. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- J. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.05 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: Enclosure must be a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel).
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
- F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.01 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 4X.
- B. Outdoor Locations: UL 50E, Type 4X.
- C. Wash-Down Areas: UL 50E, Type 4X.
- D. Other Wet or Damp, Indoor Locations: UL 50E, Type 4.
- E. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.02 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
 - 3. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
 - 4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
 - 5. Install fuses in fusible devices.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

- A. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.

- e. Verify that fuse sizes and types match the Specifications and Drawings.
- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

B. Tests and Inspections for Molded-Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that unit is clean.
- e. Operate circuit breaker to ensure smooth operation.

- f. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 MΩ.
- e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

- f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
- 3. Test and adjust controls, remote monitoring, and safeties.
- C. Nonconforming Work:
 - 1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.
- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

PART 4 - MEASUREMENT AND PAYMENT

- A. Enclosed Switches and Circuit Breakers as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.02 DEFINITIONS

- A. CPT: Control power transformer.
- B. DDC: Direct digital control.
- C. EMI: Electromagnetic interference.
- D. OCPD: Overcurrent protective device.
- E. PID: Control action, proportional plus integral plus derivative.
- F. RFI: Radio-frequency interference.
- G. VFC: Variable-frequency motor controller.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
- B. Shop Drawings: For each VFC indicated.
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.
 - 1. Certificate of compliance.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- 3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.
- C. Product certificates.
- D. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1.07 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
 - 1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. Application: variable torque.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1 motors.
 - 2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
4. Under- and overvoltage trips.
5. Inverter overcurrent trips.
6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
7. Critical frequency rejection, with three selectable, adjustable deadbands.
8. Instantaneous line-to-line and line-to-ground overcurrent trips.
9. Loss-of-phase protection.
10. Reverse-phase protection.
11. Short-circuit protection.
12. Motor-overtemperature fault.

- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
 - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 - 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 - 3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
 - 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 - 5. NC alarm contact that operates only when circuit breaker has tripped.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.03 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 0- to 10-V dc.
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).

- F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
 - 1. Number of Loops: One.

2.04 BYPASS SYSTEMS

- A. Bypass Operation: Manually transfers motor between power converter output and bypass circuit. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, IEC-rated contactor.
 - 2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
 - 4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
 - 6. Overload Relays: NEMA ICS 2.

2.05 OPTIONAL FEATURES

- A. Damper control circuit with end-of-travel feedback capability.

- B. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.06 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 4X.
 - 3. Wash-Down Areas: Type 4X.
 - 4. Other Wet or Damp Indoor Locations: Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.07 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - 1. Push Buttons: Covered.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
- B. NC bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable pneumatic time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour meter.
- F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."
- B. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
 - 1. Curbs and roof penetrations are specified in Section 07 72 00 "ROOF ACCESSORIES."
 - 2. Structural-steel channels are specified in Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."
- C. Seismic Bracing: Comply with requirements specified in Section 26 05 48.16 "SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch VFC.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 28 13 "FUSES."
- G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Comply with NECA 1.

3.02 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 26 05 23 "CONTROL-VOLTAGE ELECTRICAL POWER CABLES."
- B. Bundle, train, and support wiring in enclosures.

3.03 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the City before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. VFCs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.05 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for

NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Engineer before increasing settings.

- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 "COORDINATION STUDIES."
- F. Set field-adjustable pressure switches.

3.06 DEMONSTRATION

- A. Train City's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

PART 4 - MEASUREMENT AND PAYMENT

- A. Variable-Frequency Motor Controllers as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 51 19

LED INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Recessed, linear.
 - 2. Surface mount, linear.
 - 3. Materials.
 - 4. Luminaire support.

1.02 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Sustainable Design Submittals
- D. Samples: For each luminaire and for each color and texture with standard factory-applied finish.
- E. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
 - 1. Include Samples of luminaires and accessories involving color and finish selection.
- F. Samples for Verification: For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.
- G. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment and luminaires will be attached.
 - 5. Initial access modules for acoustical tile, including size and locations.
 - 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
 - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of luminaire.
 - E. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - F. Sample warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.07 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 1. Obtain Engineer's approval of luminaires in mockups before starting installations.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.09 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance:
 1. Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 2. Luminaires and lamps shall be labeled vibration and shock resistant.
 3. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
- B. Ambient Temperature: 41 to 104 deg F.
 1. Relative Humidity: Zero to 95 percent.
- C. Altitude: Sea level to 1000 feet.

2.02 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.

- c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- F. California Title 24 compliant.

2.03 RECESSED, LINEAR A4

- A. Lithonia Lighting / 2BLT4 40L ADP MVOLT LP835
- B. Nominal Operating Voltage: 120 -277 V ac.
- C. Lamp:
 - 1. Minimum 4000 lm.
 - 2. Minimum allowable efficacy of 85 lm/W.
 - 3. CRI of minimum 80. CCT of 3500 K.
 - 4. Rated lamp life of 35,000 hours to L70.
 - 5. Dimmable from 100 percent to zero percent of maximum light output.
 - 6. Internal driver.
 - 7. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
 - 8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Painted finish.
 - 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Clear, UV-stabilized acrylic.
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Glass: Annealed crystal glass unless otherwise indicated.
 - 4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.

2.04 SURFACE MOUNT, LINEAR, V1

- A. Lithonia Lighting / FMVCCLS 24 IN MVOLT 35K 90CRI BN
- B. Nominal Operating Voltage: 120 – 277 V ac.
- C. Lamp:
 1. Minimum 1000 lm.
 2. Minimum allowable efficacy of 75 lm/W.
 3. CRI of minimum. CCT of 3500 K.
 4. Rated lamp life of 35,000 hours to L70.
 5. Dimmable from 100 percent to zero percent of maximum light output.
 6. Internal driver.
 7. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
 8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
 1. Extruded-aluminum housing and heat sink.
 2. Painted finish.
 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 1. Clear, UV-stabilized acrylic.
 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 3. Glass: Annealed crystal glass unless otherwise indicated.
 4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- G. Standards:
 1. ENERGY STAR certified.
 2. RoHS compliant.
 3. UL Listing: Listed for damp location.

2.05 SURFACE MOUNT, LINEAR, C1

- A. QTRAN / VV2SW 1.5 35 DRY STD 45 P1 BW CLS SST ST 90
- B. Nominal Operating Voltage: 24 V dc.
- C. Lamp:
 - 1. Minimum 1125 lm.
 - 2. Minimum allowable efficacy of 75 lm/W.
 - 3. CRI of minimum 80. CCT of 3500K.
 - 4. Rated lamp life of 35,000 hours to L70.
 - 5. Dimmable from 100 percent to zero percent of maximum light output.
 - 6. Internal driver.
- D. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Painted finish.
 - 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Prismatic acrylic.
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- G. Standards:
 - 1. ENERGY STAR certified.
 - 2. RoHS compliant.
 - 3. UL Listing: Listed for damp location.

2.06 SURFACE MOUNT, LINEAR, C2

- A. QTRAN / VV2SW 1.5 35 DRY STD 45 S1 BW CLS SST ST 24
- B. Nominal Operating Voltage: 24 V dc.
- C. Lamp:
 - 1. Minimum 300 lm.
 - 2. Minimum allowable efficacy of 75 lm/W.
 - 3. CRI of minimum 80. CCT of 3500K.
 - 4. Rated lamp life of 35,000 hours to L70.
 - 5. Dimmable from 100 percent to zero percent of maximum light output.
 - 6. Internal driver.

- D. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Painted finish.
 - 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Prismatic acrylic.
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- G. Standards:
 - 1. ENERGY STAR certified.
 - 2. RoHS compliant.
 - 3. UL Listing: Listed for damp location.

2.07 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
 - 1. Manufacturer's standard grade.
 - 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.

2.08 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.09 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.03 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES" for wiring connections.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.06 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 26 09 43.16 "ADDRESSABLE-LUMINAIRE LIGHTING CONTROLS."
- B. Comply with requirements for startup specified in Section 26 09 43.23 "RELAY-BASED LIGHTING CONTROLS."

3.07 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied

conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires consistent with photometric reports.

PART 4 - MEASUREMENT AND PAYMENT

- A. LED Interior Lighting as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 26 52 13

EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting.
 - 2. Exit signs.
 - 3. Materials.
 - 4. Luminaire support components.

1.02 DEFINITIONS

- A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.
- B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - a. Include data on features, accessories, and finishes.
 - b. Include physical description of unit and dimensions.
 - c. Battery and charger for light units.
 - d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.
- B. Shop Drawings:
 - 1. For nonstandard or custom luminaires.
 - a. Include plans, elevations, sections, and mounting and attachment details.

- b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Include diagrams for power, signal, and control wiring.
- C. Sustainable Design Submittals
- D. Samples: For each product and for each color and texture specified.
- E. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.
- F. Samples for Verification: For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.
- G. Product Schedule:
 - 1. For emergency lighting units. Use same designations indicated on Drawings.
 - 2. For exit signs. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of luminaire.
- B. Product Test Reports: For each luminaire for tests performed by, or under supervision of, qualified luminaire photometric testing laboratory.
- C. Sample Warranty: For manufacturer's warranty.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.06 QUALITY ASSURANCE

- A. FM Global Compliance: Luminaires for hazardous locations must be listed and labeled for indicated class and division of hazard by FM Global.
- B. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Engineer's approval of luminaires and signs in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups will become part of Record Documents.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.08 WARRANTY

- A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.
 1. Extended Warranty Period: Two year(s) from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty for Batteries for Emergency and Exit Lighting: Manufacturer warrants that batteries for emergency luminaires and exit signs perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended warranty period.
 1. Extended Warranty Period: Five year(s) from date of Substantial Completion; prorated coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B. Comply with NFPA 101.
- C. Comply with NEMA LE 4 for recessed luminaires.
- D. Comply with UL 1598 for fluorescent luminaires.
- E. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
- F. Bulb Shape: Complying with ANSI C79.1.

- G. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate two LEDlamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 5. Charger: Fully automatic, solid-state, constant-current type.
 6. Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by emergency power unit manufacturer, whichever is less.
 7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 9. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 10. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.02 EMERGENCY LIGHTING

- A. General Characteristics: Self-contained units.
- B. Emergency Luminaire: Y1
1. Lithonia Lighting / EU2L
 2. Options:
 - a. Operating at nominal voltage of 120 V(ac).
 - b. Internal emergency power unit.
 - c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
 - d. UL 94 5VA flame rating.
- C. Emergency Lighting Unit: Y2
1. Lithonia Lighting / AFF OEL DWHGXD UVOLT LTP SDRT FCT BAA
 2. Options:
 - a. Operating at nominal voltage of 120 – 277 V(ac).
 - b. Wall with universal junction box adaptor.
 - c. UV stable thermoplastic housing, rated for damp locations.
 - d. Two LED lamp heads.
 - e. Internal emergency power unit.

2.03 EXIT SIGNS

- A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Sign: X1
 - 1. Lithonia Lighting / LQM S W 3 R MVOLT
 - 2. Options:
 - a. Operating at nominal voltage of 120 – 277 V ac.
 - b. Lamps for AC Operation:
 - 1) LEDs; 50,000 hours minimum rated lamp life.
 - c. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.04 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components must be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions.
 - 2. Designed to permit relamping without use of tools.
 - 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Clear, UV-stabilized acrylic.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Housings:
 - 1. Extruded aluminum housing and heat sink.
 - 2. Painted finish.
- E. Conduit: ERMCo, minimum metric designator 21 (trade size 3/4).

2.05 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.06 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.106 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Install lamps in each luminaire.
- C. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices must be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- D. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.

3.03 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.04 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- C. Nonconforming Work:
 - 1. Luminaire will be considered defective if it does not pass operation tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

3.05 SYSTEM STARTUP

- A. Perform startup service:
 - 1. Charge emergency power units minimum of one hour and depress switch to conduct short-duration test.
 - 2. Charge emergency power units minimum of 24 hours and conduct one-hour discharge test.

3.06 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect luminaires. Replace lamps, emergency power units and luminaires that are defective.
 - a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
 - 2. Conduct short-duration tests on all emergency lighting.

3.07 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

PART 4 - MEASUREMENT AND PAYMENT

- A. Emergency and Exit Lighting as specified herein shall be included in the measurement and payment for "Electrical Distribution".

- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 27 00 10

SUPPLEMENTAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Supplemental requirements generally applicable to the Work specified in Division 27.

1.02 REFERENCES

A. Abbreviations and Acronyms for Communications:

1. LAN: Local area network.
2. PoE: Power over Ethernet.
3. POTS: Plain old telephone service. See "public switched telephone network."
4. TCP/IP: Transmission control protocol/Internet protocol.
5. WAN: Wide area network.

B. Definitions for Communications:

1. Calling Party Control (CPC): A momentary break in phone line loop current, which is used to signal voicemail and other automated telephone company services that distant party has hung up.
2. Private Branch Exchange (PBX): Analog telephone switch that routes calls internal to a business or organization so a direct external line for each phone is unnecessary.
3. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted-pair cables from a telephone-provider central office for the transmission medium. PSTN refers to the telephone network; POTS refers to the individual subscriber line.
4. Remote Office Phone System (ROPS): VoIP system that allows phones for a business or organization located anywhere in the world with internet connectivity to behave similar to phones connected to a PBX.
5. Ringer Equivalence Number (REN): The loading effect of a single traditional telephone ringing circuit. TIA-968 defines REN 1 as an impedance of 7000 Ω at 20 Hz (Type A ringer) or 8000 Ω from 15 Hz to 68 Hz (Type B ringer). The sum of the RENs for all devices on a subscriber line circuit may not exceed the maximum permitted REN for the subscriber line.
6. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.

1.03 COORDINATION

A. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by City or others unless permitted under the following conditions:

1. Notify City no fewer than seven days in advance of proposed interruption of telephone service.

2. Do not proceed with interruption of telephone service without City's written permission.
- B. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by City or others unless permitted under the following conditions:
 1. Notify City no fewer than seven days in advance of proposed interruption of internet service.
 2. Do not proceed with interruption of internet service without City's written permission.

1.04 PREINSTALLATION MEETINGS

- A. Communications Pre-Construction Meeting: Schedule meeting with the Engineer no later than 10 days after notice to proceed. Agenda topics include, but are not limited to, the following:
 1. Installation schedule for communications systems.
 2. Value analysis proposals and requests for substitution of communications equipment.
 3. Utility services work coordination and monitoring service requests.
 4. Commissioning activities.
 5. Sustainability activities.

1.05 ACTION SUBMITTALS

- A. Coordination Drawings: Submit multidiscipline coordination drawings depicting communications equipment, devices, cabling, conduit, and duct banks in accordance with requirements specified in Section 26 00 10 "SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL."

1.06 INFORMATIONAL SUBMITTALS

- A. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of communications work to Engineer including, but not limited to, milestone dates for the following activities:
 1. Submission of specified coordination drawings.
 2. Submission of action submittals specified in Division 27.
 3. Orders placed for major equipment.
 4. Arrival of major equipment on-site.
 5. Preinstallation meetings specified in Division 27.
 6. Telephone and internet service outages.
 7. Telephone and internet service inspection and activation.
 8. Mockup reviews.
 9. Closing of walls and ceilings containing communications Work.
 10. System startup, testing, and commissioning activities for communications equipment.
 11. System startup, testing, and commissioning activities for Work specified in other divisions that depends on Work specified in Division 27.
 12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 13. Requests for special inspections.
 14. Requests for inspections by authorities having jurisdiction.
- B. Certificates:
 1. Welding certificates.

2. Seismic-Load Performance Certificates: Provide special certification as indicated in Paragraph 13.2.2 "Special Certification Requirements for Designated Seismic Systems" of ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, for designated seismic-load systems identified on Drawings or in the Specifications.
 - a. Include the following information:
 - 1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4) Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
 - 5) Provide equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction, or experience data as permitted by ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
 - 6) Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
 - 7) Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.
 - b. The following systems and components are designated seismic-load systems requiring written special certification of seismic qualification by manufacturer:
 - 1) Pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions specified in Section 27 05 28 "Pathways for Communications System."
 - 2) Hangers and supports specified in Section 27 05 29 "Hangers and Supports for Communications."
 - 3) Seismic controls specified in
3. Wind-Load Performance Certificates: Provide special certification for designated wind-load systems and components identified on Drawings or in the Specifications.
 - a. Include the following information:
 - 1) Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
 - 2) Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

C. Qualification Statements:

1. For qualified regional manufacturer.
2. For structural professional engineer.

3. For communications design professional.
4. For welder.
5. For communications cable Installer.
6. For communications testing agency and on-site communications testing supervisor.
7. For structural testing and inspecting agency.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:
2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Manufacturer's instructions for setting field-adjustable components.
 - f. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.

B. Software and Firmware Operational Documentation: Provide software and firmware operational documentation, including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.

C. Software:

1. Program Software Backup: Provide username and password for approved online or cloud solution.
2. Provide upgrades and unrestricted licenses for Government use to the City for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.08 QUALIFICATIONS

- A. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 01 40 00 "QUALITY REQUIREMENTS," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
- B. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 01 40 00 "QUALITY REQUIREMENTS," with expertise in structural engineering.

- C. Communications Design Professional: Design professional possessing active qualifications specified in Section 01 40 00 "QUALITY REQUIREMENTS" and the following:
 - 1. Expertise in design of communications infrastructure and distribution equipment.
 - 2. BICSI Registered Communications Distribution Designer (RCDD) certification.
- D. Welder: Installer possessing active qualifications specified in Section 01 40 00 "QUALITY REQUIREMENTS," with training and certification in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M.
- E. Communications Cable Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" and the following:
 - 1. Training and manufacturer certification to install, splice, and terminate communications cabling.
 - 2. Installation Supervisor: BICSI Technician (TECH) certification.
 - 3. Copper Installers: 30 percent of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
 - 4. Fiber Installers: 30 percent of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
- F. Communications Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site communications testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI testing standards.
- G. Structural Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 01 40 00 "QUALITY REQUIREMENTS" with documented training and experience with testing structural concrete, seismic controls, and wind-load controls.

1.09 FIELD CONDITIONS

- A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 27.

PART 2 - PRODUCTS

2.01 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

- A. Substitution requests for communications equipment will be entertained under the following conditions:
 - 1. Substitution requests may be submitted per General Conditions GC-3.4.7 for consideration prior to the Communications Preconstruction Meeting if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for City throughout life of facility.
 - 2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

PART 3 - EXECUTION

3.01 INSTALLATION OF COMMUNICATIONS WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' instructions, comply with NFPA 70, NECA NEIS 1, and BICSI N1 for installation of Work specified in Division 27. Consult Engineer for resolution of conflicting requirements.

3.02 FIELD QUALITY CONTROL

- A. Administrant for Communications Tests and Inspections:
 - 1. City will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 3. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- B. Administrant for Structural Tests and Inspections:
 - 1. City will engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

PART 4 - MEASUREMENT AND PAYMENT

- A. Supplemental Requirements for Communications as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Tele-power poles.
9. Hooks.
10. Boxes, enclosures, and cabinets.
11. Polymer-concrete handholes and boxes for exterior underground cabling.
12. Fiberglass handholes and boxes for exterior underground cabling.

1.02 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.03 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.
5. Underground handholes and boxes.

B. Sustainable Design Submittals

- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

- D. Samples: For wireways, nonmetallic wireways surface pathways and for each color and texture specified, 12 inches long.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Seismic rating, Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated GRC IMC.

1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set screw or compression.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 2. Comply with TIA-569-D.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Rigid HDPE: Comply with UL 651A.
- E. Continuous HDPE: Comply with UL 651A.
- F. RTRC: Comply with UL 2515A and NEMA TC 14.
- G. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

- C. Comply with TIA-569-D.

2.04 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.05 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.06 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Finish: Manufacturer's standard enamel finish in color selected by Engineer.

- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.07 SURFACE NONMETALLIC PATHWAYS:

- A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.
- B. Finish: Texture and color selected by Engineer from manufacturer's standard colors.
- C. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with TIA-569-D.

2.08 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Galvanized stainless steel.
- E. J U shape.

2.09 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 4. Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep.
 - 5. Gangable boxes are allowed.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: Fully adjustable Semi-adjustable.
 - 3. Shape: Rectangular.
 - 4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R, with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures:
 - a. Material: Plastic Fiberglass.
 - b. Finished inside with radio-frequency-resistant paint.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
 - 1. NEMA 250, Type 1 Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EM Tor RNC.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT RNC identified for such use.
 - 3. Exposed and Subject to Severe Physical Damage: GRC IMC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT RNC, Type EPC-40-PVC or innerduct.
 5. Damp or Wet Locations: GRC IMC.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway Plenum-type, communications-cable pathway EMT.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel nonmetallic units in institutional and commercial kitchens and damp or wet locations.
- B. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use set-screw or compression, steel fittings. Comply with NEMA FB 2.10.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 27 05 29 "HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS" for hangers and supports.

- E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- F. Complete pathway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- J. Support conduit within 12 inches of enclosures to which attached.
- K. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- S. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- U. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- V. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- X. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - b. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.

2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet o.c.
 5. Provide a hook at each change in direction.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

PART 4 - MEASUREMENT AND PAYMENT

- A. Pathways for Communications Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, shown and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M AWS D1.2/D1.2M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "QUALITY REQUIREMENTS," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles, with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Material for Channel, Fittings, and Accessories: Galvanized steel Stainless Steel, Type 304 Stainless Steel, Type 316.
 3. Channel Width: 1-5/8 inches 1-1/4 inches.
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Stainless-steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 6. Toggle Bolts: Stainless-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "METAL FABRICATIONS" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-C.
 - 4. NECA 101.
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 27 05 28 "PATHWAYS FOR COMMUNICATIONS SYSTEMS."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps single-bolt conduit clamps single-bolt conduit clamps, using spring friction action for retention in support channel.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "METAL FABRICATIONS" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 09 91 23 "INTERIOR PAINTING" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

PART 4 - MEASUREMENT AND PAYMENT

- A. Hangers and Supports for Communications Systems as specified herein shall be included in the measurement and payment for "Electrical Distribution".

- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Cable management system.

1.02 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules:
 - a. Electronic copy of labeling schedules, in software and format selected by City.
 - b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 2. Cabling administration Drawings and printouts.
 - 3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment.

- C. Twisted pair cable testing plan.
- D. Sustainable Design Submittals
- E. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and cover plates for color selection and evaluation of technical features.
- F. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.07 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with City's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated:
 - a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
 - b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
 - 2. Communications, Non-Plenum Rated:
 - a. Type CMR complying with UL 1666.
 - b. Type CMP or Type CMR in listed plenum or riser communications raceway.
 - c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.03 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP).
- E. Cable Rating: Plenum.

- F. Jacket: Blue thermoplastic.

2.04 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- D. Connecting Blocks:
 - 1. 66-style IDC for Category 6.
 - 2. 110-style IDC for Category 6.
 - 3. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on existing IT cabinet.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
- G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
- H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

J. Cover Plate:

1. Two Four port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 26 05 33.16 "Boxes and Covers for Electrical Systems."
3. Metal Cover Plate: Stainless steel, complying with requirements in Section 26 05 33.16 "Boxes and Covers for Electrical Systems."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.05 CABLE MANAGEMENT SYSTEM

- A. Description: Computer-based cable management system, with integrated database and graphic capabilities.
- B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.
- C. Information shall be presented in database view, schematic plans, or technical drawings.
 1. AutoCAD drawing software shall be used as drawing and schematic plans software.
- D. System shall interface with the following testing and recording devices:
 1. Direct upload tests from circuit testing instrument into the personal computer.
 2. Direct download circuit labeling into labeling printer.

PART 3 - EXECUTION

3.01 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. Routing: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "PATHWAYS FOR COMMUNICATIONS SYSTEMS."
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.
- D. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.1.
 - 2. Comply with BICSI's Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
 - 12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.02 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "PENETRATION FIRESTOPPING."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.03 GROUNDING

- A. Comply with requirements for grounding conductors and connectors.
- B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- C. Comply with TIA-607-B and NECA/BICSI-607.
- D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.04 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for level of administration.
- C. Equipment grounding conductors.
- D. Cable and Wire Identification:
 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

- a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
- 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.05 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation.
- B. Field tests and inspections must be witnessed by City authorities having jurisdiction.
- C. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
- D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- E. Nonconforming Work:
 - 1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- F. Collect, assemble, and submit test and inspection reports.
- G. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support supervise field tests and inspections.

3.06 MAINTENANCE

- A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for two years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.
 - a. Upgrade Notice: No fewer than 30 days to allow City to schedule and access the system and to upgrade computer equipment if necessary.
3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

PART 4 - MEASUREMENT AND PAYMENT

- A. Communications Copper Horizontal Cabling as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. The following are addressed in this Section:
 - 1. Excavation, Trenching, and Stockpiling.
 - 2. Excavation Support Systems.
 - 3. Backfilling and Compaction.
 - 4. Grading.
 - 5. Import Soil.
 - 6. Fill Material.
 - 7. Surplus Soil.
 - 8. Non-Hazardous Waste.
 - 9. VOC-Contaminated Soil.
 - 10. Stained or Odorous Material.
- B. Per the requirements of this Section, Contractor shall perform all earthwork, to the lines, grades, and elevations as specified and shown by the Contract Documents including:
 - 1. Excavation of on-site Soil as shown on the Drawings, including but not limited to excavation for utility trenches.
 - 2. Re-handling of excavated Soil determined to be Fill Material and used as Backfill Material.
 - 3. Testing, characterization, loading, hauling, and placement of Import Soil.
 - 4. Testing, characterization, loading, and hauling of Soil.
 - 5. Placement, moisture control, compaction, and grading of Bedding, Backfill Material and Structure Backfill Material.
 - 6. Preparation of subgrades for slabs-on-grade, pavements, subsurface utilities, subsurface structures, and foundations.
 - 7. Providing shoring, sheeting and bracing required for temporary support of existing utilities and structures during excavation, for installation of new utilities and backfill operations, and for worker protection in excavations.
- C. All material for disposal must be stockpiled prior to being tested and characterized. Additional testing required due to Contractor's failure to stockpile will be at Contractor's expense.
 - 1. Soil Material unsuitable for reuse shall be disposed of outside the Harbor District per the Contract Documents.

2. Soil Material suitable for reuse shall be excavated, segregated, stockpiled, tested, characterized, profiled, loaded, and hauled to a designated location within the Harbor District as specified per the Contract Documents.
 3. Stained or Odorous Material encountered during earthwork shall be excavated, segregated, stockpiled, tested, characterized, profiled, loaded, hauled, and disposed of at an approved offsite disposal facility or facilities as Non-Hazardous Waste, per the requirements of this Section.
 4. VOC-Contaminated Soil encountered during earthwork shall be excavated, segregated, stockpiled, tested, characterized, profiled, loaded, hauled, and disposed of at an approved offsite disposal facility or facilities as Non-Hazardous Waste, per the requirements of this Section.
- D. Excavation of Soil identified in this Section shall be performed only to the extent necessary to facilitate construction activities as shown on the Contract Documents. The areas of Soil have been pre-characterized as Non-Hazardous Waste. Excavation, handling, stockpiling, testing, characterization, loading, hauling, and disposal of Soil from the performance of earthwork as specified and shown on the Contract Documents shall be performed per the requirements of this Section.
- E. Management of Stained or Odorous Material shall be performed per the requirements of this Section.
- F. Management of VOC-Contaminated Soil, per the SCAQMD Rule 1166 Various Locations Permit or site-specific Contaminated Soil Mitigation Plan shall be performed per the requirements of this Section.
- G. Earthwork also includes the environmental testing and management of both Import Soil and excavated Soil per the requirements of the Contract Documents and this Section.

1.02 DEFINITIONS

- A. Active Dewatering: Removal of water from the ground that results in the lowering of the Groundwater Table outside of trenching and excavation areas.
- B. Backfill Material: Fill Material or Import Soil used for earthwork per the Contract Documents and shall conform to the requirements of this Section.
- C. Base Material: Aggregate base course material that is part of the on-site pavement and roadway structural section free of deleterious material.
- D. Bedding: Material placed under and/or around utilities and substructures, conforming to the requirements of this Section.
- E. Cal/EPA: California Environmental Protection Agency.
- F. Cal/OSHA: California Department of Industrial Relations, Division of Occupational Safety and Health Administration.
- G. CCR: California Code of Regulations.

- H. CFR: Code of Federal Regulations.
- I. COPCs: Chemicals of Potential Concern - A substance that has the potential to affect human receptors adversely due to its concentration, distribution, and mode of toxicity.
- J. ELAP: Environmental Laboratory Accreditation Program.
- K. Exclusion Zone: Defined and secured Work area required for removal of Hazardous Waste per 29 CFR Part 1910.120.
- L. Fill Material: Soil excavated within the Project Limits, but outside of areas where Stained or Odorous Material, VOC-Contaminated Soil, Hazardous Waste, or Non-Hazardous Waste is encountered; and is accepted for use within the Project Limits as Bedding or Backfill Material, per the Contract Documents.
- M. Groundwater: Subsurface water that fills available voids in Soil to the extent that the Soil is saturated.
- N. Groundwater Table: The surface of the Groundwater exposed to an atmospheric pressure beneath the upper limit of the Saturated Soil.
- O. Hazardous Waste: Waste characterized as a RCRA-Hazardous Waste, a TSCA-Hazardous Waste, **or** a Non-RCRA California-Hazardous Waste.
- P. Import Soil: Soil transported to the Project from a location outside of the Harbor District that is accepted for use as Bedding or Backfill Material within the Project Limits, per the Contract Documents. Import Soil shall comply with the requirements for fill material, as specified herein.
- Q. Liquid Waste: Liquid, fluid, or sludge potentially containing local, State, and Federally regulated substances, other than Storm Water managed under the requirements of Special Conditions SC-18.1 of these Specifications, that is removed by the Contractor during the performance of the Work, per the requirements of this Section.
- R. NIOSH: National Institute for Occupational Safety and Health.
- S. Non-Hazardous Waste: Waste **not** characterized as: a RCRA-Hazardous Waste, a TSCA-Hazardous Waste, or a Non-RCRA California-Hazardous Waste.
- T. Non-RCRA California Hazardous Waste: Waste characterized as a Non-Resource Conservation and Recovery Act (Non-RCRA), California-Hazardous Waste per 22 CCR Section 66261.
- U. OCPs: Organochlorine Pesticides.
- V. OSHA: U.S. Department of Labor, Occupational Safety and Health Administration.
- W. PAHs: Polycyclic Aromatic Hydrocarbons.
- X. PCBs: Polychlorinated Biphenyls.

- Y. PPE: Personal Protective Equipment.
- Z. ppmv: parts per million by volume.
- AA. Profile Documentation: Characterization data, profiles and manifests required for offsite disposal of Waste.
- BB. RCRA: Resource Conservation and Recovery Act.
- CC. RCRA-Hazardous Waste: Waste characterized as a Resource Conservation and Recovery Act (RCRA) Hazardous Waste, per 40 CFR Parts 260 through 265.
- DD. Saturated Soil: A condition in which voids in Soil are filled with water, resulting in poor bearing capacity and/or Soil “pumping” conditions.
- EE. SCAQMD: South Coast Air Quality Management District.
- FF. Soil: Sand, silt, or clay mixture or other solid material (e.g., gravel, rock), but excluding concrete and asphaltic debris.
- GG. SSPWC: Standard Specifications for Public Works Construction (also known as the “Greenbook”).
- HH. SSSP: Site Specific Safety Plan.
- II. Stained or Odorous Material: Soil that exhibits visual or olfactory evidence of petroleum hydrocarbon or other contamination.
- JJ. Standing Water: Accumulation of stagnant water found on the ground and in excavations, including but not limited to water that is void of movement by either natural or artificial means and including, but not limited to, moisture.
- KK. STLC: Soluble Threshold Limit Concentration – Concentration of an organic or inorganic contaminant in a liquid extract that characterizes that Waste as hazardous per 22 CCR Section 66261.
- LL. Storm Water: Water originating from rainfall events that results in surface water runoff or drainage.
- MM. Structure Backfill Material: Backfill Material placed around structures per the requirements of the Contract Documents and conforming to the requirements of this Section.
- NN. Surplus Soil Reuse Material: Soil that is tested and characterized as Non-Hazardous Waste, meeting the requirements specified herein, and accepted for reuse within the Harbor District.
- OO. SVOCs: Semi-Volatile Organic Compounds.
- PP. SWPPP: Storm Water Pollution Prevention Plan.
- QQ. TCLP: Toxicity Characteristic Leaching Procedure - USEPA procedure to determine mobility of organic and inorganic contaminants to determine whether Waste is hazardous per 40 CFR Part 261.24.

- RR. TPH: Total Petroleum Hydrocarbons.
- SS. TSCA: Toxic Substances Control Act.
- TT. TSCA-Hazardous Waste: Waste Characterized as a Toxic Substances Control Act (TSCA) Polychlorinated Biphenyl (PCB) Hazardous Waste, per 40 CFR Part 761.
- UU. TTLC: Total Threshold Limit Concentration - Concentration of an organic or inorganic contaminant in a Solid Waste that characterizes that Waste as hazardous per 22 CCR Section 66261.
- VV. USEPA: U.S. Environmental Protection Agency.
- WW. VOCs: Volatile Organic Compounds.
- XX. VOC-Contaminated Soil: Excavated soil with VOC vapor concentrations greater than 50 ppmv per SCAQMD Rule 1166.
- YY. Waste: Solid, liquid, or gaseous material that is not suitable for its original intended purpose at the Site or a material characterized as a waste by a regulatory authority.
- ZZ. Watertight: A joint, enclosure, or assembly that is designed and of such tight construction as to prohibit the entry of water.
- AAA. Wet Conditions: Underground Work in direct contact with Saturated Soil.

1.03 REFERENCES

- A. Environmental Report "Limited Phase II Environmental Sampling Report Proposed New Administration and Maintenance Buildings 669 Harbor Plaza Long Beach California, 2003" included in Appendix CC.
1. Information provided in these Appendices for pre-characterization of Soil is solely for bidding and health and safety considerations.
 2. The information presented in these Appendices is representative of the subsurface conditions within the Project Limits.
 3. The information presented in these Appendices is representative of the bid items included in this Section.
- B. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
- C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)).
- D. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- E. Cal/EPA: Regulations per CCR Title 22.
- F. Cal/OSHA: Regulations per CCR Title 8.

- G. SCAQMD Rule 1166 – Volatile Organic Compound Emissions from Decontamination of Soil.
- H. SCAQMD Rule 402 – Nuisance.
- I. SCAQMD Rule 403 – Fugitive Dust.
- J. SSPWC - Engineering Fabrics.
- K. SSPWC - Earthwork.
- L. SSPWC – Treated Soil, Subgrade Preparation, and Placement of Base Materials.
- M. SSPWC – Underground Conduit Construction.
- N. USEPA: “Test Methods for Evaluating Solid Waste - Physical/Chemical Method” (SW-846; most recent version).

1.04 REGULATIONS

- A. Contractor’s Work shall be carried out in conformance with applicable current local, State, and Federal laws, codes, ordinances and regulations of regulatory agencies having jurisdiction, including the furnishing of any required excavation drawings and supporting information to said authorities and the obtaining of permits.
- B. Contractor shall comply with the specific permit and Waste acceptance criteria of each individual offsite facility used by the Contractor for recycling or disposal of Waste, at no additional cost to the City.
- C. Contractor shall notify Underground Service Alert two (2) Working Days prior to commencing earthwork operations.
- D. Contractor shall provide and comply with Contractor’s SCAQMD Rule 1166 Various Locations Permit for the project.

1.05 QUALITY ASSURANCE

- A. Prior to commencing Work, the Contractor shall examine the Contract Documents, inspect the Site, and note all conditions and limitations that may influence Work required by this Section.
- B. Contractor shall provide the required geotechnical properties testing for import materials from all proposed sources.
- C. Contractor or Subcontractor performing Earthwork shall hold a valid Hazardous Substance Removal Certification from the California Contractors State License Board during all work that requires such certification.
- D. Contractor shall utilize the following procedures for environmental and geotechnical testing and import of Import Soil from each proposed offsite source:

1. Notify Engineer of proposed testing of each source.
 2. Coordinate with the Engineer to provide a representative to witness sampling of proposed source.
 3. Perform testing of Import Soil per requirements of this Section.
 4. Confirm that sample results conform to the Contract Documents.
 5. Submit Import Soil Environmental Characterization and Geotechnical Reports and Certificates of Compliance per the requirements of this Section to the Engineer for review and verification of conformance with Contract Documents.
 6. The Contractor shall observe the import operations each day at each source to confirm that such source(s) have been approved for use and to visually verify that all materials being loaded for transport match the appearance of the sample(s) tested. The Contractor is advised that the Engineer may do the same. The license plate numbers of all trucks loaded at the approved source shall be recorded by the Contractor as the trucks are loaded. Provide a list of license plate numbers of all trucks from each source, prior to arriving at the Site, to the Engineer on a daily basis. If a comparison of the two lists indicates that trucks' imported material was not loaded at the approved source(s), all Import Soil delivered to the Site that day shall be subject to rejection by the Engineer and shall immediately be removed from the Site at no additional cost to the City.
 7. The Engineer will require additional testing of Import Soil at no additional cost to the City, if the Engineer's observation of the Import Soil indicates that the Soil is not representative of the source(s) or sample(s) provided.
 8. For Import Soil that does not meet the geotechnical or environmental requirements of the Contract Documents, upon notice from the Engineer, the Import Soil shall be immediately removed from the Site and replaced with Import Soil that complies with the requirements of this Section at no additional cost to the City.
- E. Regulation Documents: Contractor shall maintain at all times one (1) copy at the office and one (1) copy in view at the Site, of the accepted Contractor's Removal, Storage, Transportation and Disposal Work Plan and all other Permits as specified in this Section or required by regulation or law, including addenda and revisions.
- F. Access by Engineer: The Engineer may enter Exclusion Zones for brief periods of time, provided they have documentation of proper training and utilize appropriate PPE. Contractor shall provide all required safety briefings for the Engineer as required for safe entry and performance of duties.
- G. Environmental Testing Laboratory: Contractor shall obtain the services of an environmental testing laboratory certified by the California Department of Public Health's Environmental Laboratory Accreditation Program (ELAP). Environmental testing laboratory shall not be affiliated with the Contractor. The Contractor's testing laboratory shall analyze all Soil and Liquid Waste samples submitted for chemical characterization by the Contractor.
- H. Licensed Environmental Professional (Civil Engineer or Geologist): Contractor shall obtain the services of a Civil Engineer or Geologist licensed in good standing by the California Board for Professional Engineers, Land Surveyors, and Geologists with environmental experience in Soil and Waste sampling and

Waste characterization. The Contractor's Licensed Environmental Professional or qualified designee shall provide full-time on-site supervision of the Soil and Waste sampling and Waste characterization activities associated with construction-related Soil handling and characterization and provide recommendations regarding the Waste characterization of such Soil for review by the Engineer. The qualifications of the Contractor's Licensed Environmental Professional shall comply with this Section.

1.06 SUBMITTALS

- A. Contractor shall prepare and submit the items listed below in accordance with the requirements of SECTION 01 33 00, "SUBMITTAL PROCEDURES". Each submittal shall be provided to the Engineer for review a minimum of twenty-one (21) calendar days (unless otherwise noted) before any earthwork proceeds.
1. Prior to hauling, Contractor shall submit Existing Pavement Investigation report. The Contractor-prepared report shall have photo documentation and a detailed narrative of pavement conditions within project limits. The Contractor shall be responsible for restoring the existing pavement surfaces to the condition as documented in the report and as accepted in the submittal, prior to Affidavit of Final Completion.
 2. An Excavation Work Plan outlining intended excavation and backfilling procedures proposed for the Project.
 3. Shoring system design and construction procedures including shop drawings and calculations prepared by a California licensed Civil or Structural Engineer for shoring conforming to the requirements of this Section. Shop drawing resubmittal to Engineer for review may be required if configuration or field conditions change.
 4. Steel plate design including shop drawings and calculations prepared by a California-licensed Civil or Structural Engineer for steel plates conforming to the requirements of this Section. Shop drawings shall include proposed method of pinning (anchoring) and asphalt concrete tapered edging. Shop drawing resubmittal to Engineer for review may be required if configuration or field conditions change, as directed by the Engineer. Contractor is responsible for providing design of steel plates.
 5. Hauling Plan: Contractor shall submit detailed hauling plan and comply with SECTION 01 55 26 "TRAFFIC CONTROL" or SECTION 01 57 19 "TEMPORARY ENVIRONMENTAL CONTROLS". At a minimum, Plan shall include a map showing the route, BMPs, source sites (contact name, address, and phone number), hauling dates, hauling times, estimated trips per day, equipment to be used, necessary traffic control procedures, and methods to keep material off public streets.
 6. Import Soil Environmental Sampling and Testing Plan: Contractor shall submit plan for sampling and testing of Import Soil sources for compliance with these Specifications.
 7. Import Soil Geotechnical Sampling and Testing Plan: Contractor shall submit plan for sampling and testing of all sources of Import Soil (including Bedding, Backfill Material and Structure Backfill Material) that

conforms to the geotechnical requirements of this Section. Geotechnical Soil testing shall be performed per applicable ASTM Methods.

8. Geotechnical Samples: Per the Import Soil Geotechnical Sampling and Testing Plan submittal, Contractor shall submit samples of not less than thirty (30) pounds of Import Soil for each proposed offsite source. Notify the Engineer in writing a minimum of two (2) Working Days in advance of taking samples so that the Engineer can observe the sampling.
9. Environmental Characterization Report: Contractor shall submit a soil characterization report in accordance with this Section.
10. Import Soil Geotechnical Report: Contractor shall submit chain of custody record for each sample (including contract number, identification of items tested, quantity of material tested, date test performed, name of tester, and acceptance criteria), laboratory data sheets, test results reports, and certificate of compliance with Contract Specifications for all Import Soil (including crushed rock, Bedding, Backfill Material, and Structure Backfill Material) obtained from proposed offsite sources.
11. Import Soil Testing Notification: Contractor shall submit written notice to the Engineer of Import Soil testing seven (7) calendar days prior to testing the Soil from the source.
12. Import Soil Hauling: Contractor shall submit written notice to the Engineer of Import Soil hauling two (2) Working Days prior to importing the Soil from the source.
13. Hauling Load Tickets: Contractor shall submit daily load tickets, with respective certified tare weights, from a licensed California Weighmaster for all corresponding loads hauled to or from the Work Site.
14. Notifications, Permits, and Approvals:
 - a. Contractor shall notify the Engineer a minimum of fourteen (14) calendar days prior to the start of excavation of Soil.
 - b. Contractor shall provide copies of required regulatory permits or approvals and appropriate regulatory agency notifications in accordance with permit requirements.
 - c. Contractor shall provide all required notifications to the Engineer and applicable agencies in accordance with all permit requirements.
 - d. Contractor shall provide proof of Hazardous Substance Removal Certification in accordance with Contractors State License Board requirements fourteen (14) calendar days prior to the start of excavation of Soil.
15. Removal, Storage, Transportation, and Disposal Work Plan: Contractor shall prepare and submit a Removal, Storage, Transportation and Disposal Work Plan that details the following:
 - a. Sequencing of the Soil excavation work by location, estimated volume/tonnage, and type and characterization of Soil.

- b. Proposed locations and sizes of Soil staging and Soil storage areas within the Project Limits.
 - c. Procedures for segregation of Soil.
 - d. Locations, means, and methods for storing excavated Soil and Waste (including Liquid Waste) prior to transportation in accordance with applicable permits and the requirements of this Section. Provide materials of construction, type of puncture resistant lining material and provisions for spill containment and spill control. Storage containers for Hazardous Waste shall comply with 40 CFR Part 265.
 - e. Locations, means, and methods for stockpile sampling and characterization of excavated Soil (and Liquid Waste) for disposal in accordance with this Section.
 - f. Procedures for excavation, segregation, and stockpiling of Stained or Odorous Material and VOC-Contaminated Soil, if encountered during the performance of Work.
 - g. Procedures for setting up Exclusion Zones around Work areas and decontamination areas at designated egress locations. Exclusion Zones shall be required if VOC-Contaminated Soil or Hazardous Waste is encountered.
 - h. Procedures for decontamination of equipment used within Exclusion Zones.
 - i. Procedures and equipment associated with Soil excavation including excavation methodology, and initial PPE anticipated and required upgrades, in accordance with the Contractor's SSSP.
 - j. Procedures, equipment, and materials for vapor, dust, and odor suppression, including the specifications for any proposed commercial suppression agents or materials.
16. Field Screening Results and Reports:
- a. For field screening (air monitoring) performed by Contractor, Contractor shall provide all field notes and results associated with screening potentially contaminated materials for VOCs, odor, and dust on a weekly basis.
 - b. All VOC monitoring and reporting shall be conducted by the Contractor in accordance with SCAQMD Rule 1166.
17. Environmental Testing Laboratory:
- a. Contractor shall submit a qualifications package that shall include the name of analytical laboratory(ies) to be used by the Contractor, certified by the California Department of Public Health with ELAP Certification Number.
 - b. Analytical testing results from laboratories without an ELAP Certification Number shall not be accepted for characterization of Waste.
18. Licensed Environmental Professional: Contractor shall submit a qualifications package that shall include the resume of the California-licensed Professional Civil Engineer or Geologist, a description of three

(3) representative projects completed within the last five (5) years by the proposed professional, and copy of license certificate. Representative projects shall include projects that have involved excavation, segregation, testing, characterization, profiling, and offsite disposal of a minimum of 2,000 tons of Soil contaminated with petroleum hydrocarbon contamination, including TPH, VOCs and SVOCs. Assignment of the Contractor's Licensed Environmental Professional shall be subject to review by the Engineer.

19. Disposal/Recycling Facilities: Contractor shall submit a qualifications package for any proposed disposal and/or recycling facility to be used, not already listed in Article 3.20 herein, per the requirements of this Section, that shall include the following:
 - a. Legal name, address, and contact information for the proposed offsite facility or facilities to be used for disposal/recycling of Waste.
 - b. Current regulatory permits, licenses and certifications demonstrating the regulatory status of the proposed facility or facilities to receive Waste for the specific Waste characterization(s) identified in this Section.
 - c. Statement from each proposed facility that it is fully licensed and permitted and not subject to regulatory investigation or undergoing review for renewal of its license.
20. Waste Characterization Report: Contractor shall prepare and submit Waste Characterization Report. Contractor's Licensed Environmental Professional shall review the environmental testing laboratory reports and prepare a summary report including recommendations for Waste characterization and disposition for review and approval by the Engineer prior to transport of any Waste per the requirements of this Section. The Waste Characterization Report shall be submitted to the Engineer within seven (7) calendar days of the Contractor's receipt of laboratory results. Waste Profile Documentation:
 - a. Contractor shall submit to the Engineer a completed Waste Profile application (including the Waste Characterization Report) for each Waste stream, prior to submittal to the proposed disposal facility or facilities.
 - b. Contractor shall submit copy(ies) of the approved Waste Profile Documentation from the Contractor's selected disposal facility or facilities a minimum of three (3) Working Days prior to transport of Waste (both Soil and Liquid Waste) to offsite facility or facilities.
21. Disposal Manifests:
 - a. Contractor shall submit completed sample manifest(s) for final disposition of Waste at offsite disposal facility or facilities selected by the Contractor a minimum of three (3) Working Days prior to transport of Waste to offsite facilities.
 - b. Contractor shall submit manifests to the Engineer a minimum of 48 hours prior to transport, per the requirements of this Section, for signature and record.
 - c. Contractor shall provide Generator Copy(ies) of all manifests to

the Engineer within five (5) Working Days.

1.07 PROJECT CONDITIONS

- A. The Soil onsite has been pre-characterized as Non-Hazardous Waste.
- B. The quantities of Non-Hazardous Waste indicated in the Schedule of Bid Items may exceed the quantity of excavation from the areas indicated on the Drawings where Waste may be encountered. The respective quantities indicated on the Schedule of Bid Items are an estimate of the anticipated quantities of Non-Hazardous Waste to be encountered in excavation areas within the entire Project Limits. Measurement and payment shall be at the appropriate Bid Prices for the actual quantity of the Work.
- C. The Contractor may encounter Stained or Odorous Material or VOC-Contaminated Soil during excavation within the Project Limits. Contractor shall notify the Engineer immediately if Stained or Odorous Material or VOC-Contaminated Soil is encountered.
- D. Contractor shall notify the Engineer immediately if a Non-Hazardous Waste described in the Contract Documents is characterized as a Hazardous Waste per the results of the Contractor's environmental testing.
- E. Contractor shall furnish qualified flagperson at no additional cost to the City where required based upon the Contractor's hauling plan and where required by the Contract Documents. Use of flagperson within the terminal requires review and acceptance from the Engineer.
- F. At the end of work shift, Contractor shall barricade open excavations and post with warning lights and signage. The Contractor shall operate warning lights during hours from dusk to dawn each day and as otherwise required by the Contract Documents.
- G. Contractor shall protect utilities, surface and subsurface structures, and facilities designated to remain in place from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations.
- H. Stockpile and equipment weight criteria shall adhere to the requirements on the Contract Drawings.
- I. Groundwater is not anticipated on site.

1.08 ENVIRONMENTAL PROTECTION

- A. Refer to SECTION 02 41 00, "DEMOLITION" for handling, management and disposal of hazardous materials from demolition of utilities, substructures and aboveground structures.
- B. Offsite Precautions: Contractor's equipment, after coming in contact with Waste, shall not be allowed to pass outside the Project Limits, over existing onsite access roads, offsite public roads, outside terminal boundary, or other public and private property without decontamination and protection per the Contractor's Removal, Storage, Transportation and Disposal Work Plan. Any such roads or

property which are damaged or contaminated with Waste as a result of Contractor's operations shall be restored to original condition within ten (10) Working Days from notification by the Engineer, at no additional cost to the City, including any and all construction delays.

- C. Air Quality (Vapor, Dust, and Odor) and Noise: During the execution of the Work, the Contractor shall adopt, implement, and conform to all regulatory requirements. All compliance obligations are exclusively the responsibility of the Contractor and shall be implemented at no additional cost to the City.
- D. Storm Water Runoff Management: Storm Water shall be managed in accordance with Special Conditions SC-18 and the Contractor's BMP Checklist. Any damage caused by Storm Water is exclusively the responsibility of the Contractor and shall be repaired within ten (10) Working Days at no additional cost to the City, including any and all construction delays.
- E. Standing Water Quality: During the execution of the Work, the Contractor shall adopt, implement, and conform to the regulatory requirements and the Contractor's BMP Checklist. Water entering excavations, if removed by the Contractor, shall be containerized, tested, and disposed or recycled as a Liquid Waste at an appropriate offsite facility selected by the Contractor at no additional cost to the City, per the requirements of this Section.

1.09 EXCAVATION SUPPORT SYSTEMS

- A. The Contractor shall design, furnish, construct, maintain, and remove excavation support systems used to protect workers and existing facilities during Soil excavation and backfilling in accordance with the requirements of this Section.

PART 2 - PRODUCTS

2.01 BEDDING

- A. Bedding for water line shall be sand conforming to the requirements of SSPWC 200-1.5.3.
- B. Bedding for sanitary sewer shall be concrete conforming to the requirements of SSPWC CLASS 450- C- 2000.
- C. Except as otherwise specified, Bedding shall be sand, gravel, aggregate, or Backfill Material having a sand equivalent of not less than thirty (30) or having a coefficient of permeability greater than one and one half (1 ½) inches/hour. Bedding shall be free from organic matter, clay, and excessive fines. Bedding shall be free from products of demolition, rocks, and solid debris in excess of one (1) inch in their greatest dimension.
- D. Import Soil for Bedding shall be used if quantities of Fill Material are insufficient to complete the bedding work. Engineer approval is required prior to importing Import Soil.

2.02 BACKFILL MATERIAL

- A. Backfill Material shall conform to SSPWC Section 300-4.1, except as modified herein. Backfill Material shall be free from organic matter, clay, and excessive fines. Backfill Material shall be free from products of demolition, rocks, and solid debris in excess of three (3) inches in their greatest dimension.
- B. Fill Material meeting the Backfill Material requirements shall be used as Backfill Material. Import Soil for Backfill Material shall only be used if quantities of Fill Material are insufficient to complete the backfill work. Engineer approval is required prior to importing Import Soil.
- C. Import Soil used as Backfill Material shall conform to the requirements of SSPWC Section 217-2.2.
- D. Cement slurry used as Backfill Material shall be 1 ½ sack cement slurry.

2.03 3/4-INCH CRUSHED ROCK

- A. Three-quarter (3/4) inch crushed rock shall conform to the requirements of SSPWC Section 200-1.2.

2.04 HAULING EQUIPMENT

- A. Trucks licensed for street use shall be used for hauling Soil across existing pavements. No "off-road" hauling equipment shall be permitted on any existing paved surfaces.
- B. All trucks transporting Soil or Waste offsite shall comply with 22 CCR Part 66263.16 regarding design and construction to contain Soil and Waste.

2.05 TEMPORARY STEEL PLATES

- A. Steel plates shall be designed by the Contractor to conform to the following conditions:
 - 1. Steel plates placed within ten (10) feet of the face of wharf shall support HL-93 design load.
 - 2. Steel plates placed further than ten (10) feet from the face of wharf shall support a 125 Kip design load distributed over a five (5) square-foot area.
 - 3. Steel plate thicknesses shall conform to the limitations specified in the Drawings.
 - 4. Contractor's steel plate design shall be stamped by a current California-licensed Professional Civil or Structural Engineer.
 - 5. Steel plates covering Shore Power Outlet (SPO) openings along the face of wharf shall incorporate bullrail where wharf demolition required removal of existing bullrail.

2.06 SHORING AND BRACING MATERIALS

- A. Contractor shall provide material necessary for protective systems and accessories as required to safely shore and brace excavations for worker protection.

PART 3 - EXECUTION

3.01 PREPARATION FOR FINISH ELEVATIONS AND LINES

- A. Contractor shall survey, set, and establish finish earthwork and subgrade elevations in conformance with SSPWC 2-9.4, Line and Grade, and shall conform to the subgrade tolerances specified in SSPWC 301-1.4, Subgrade Tolerances, and as approved by Engineer.

3.02 EXCAVATION

- A. Active Dewatering is prohibited.
- B. All water including, but not limited to, Groundwater and Storm Water entering excavations, trenches, and below grade structures and appurtenances that is required to be removed in order to perform the Work shall be managed, containerized, tested, characterized, profiled, and disposed by the Contractor as Liquid Waste, per the requirements of this Section, and conform to the applicable environmental protection measures in accordance with local, State, and Federal regulations. Unpermitted discharge of managed water onto the ground or into the ocean, storm drain, or sanitary sewer is prohibited.
- C. Groundwater is not anticipated.
- D. Earthwork shall be carried out to the lines, grades, and typical sections specified herein, and as shown on the Drawings.
- E. Contractor shall excavate in a manner and sequence that provides appropriate drainage at all times per the Contractor's BMP Checklist.
- F. Contractor shall perform excavation in conformance with SSPWC 300-2, Unclassified Excavation.
- G. The Contractor may employ side slope layback methods, vertical cut methods, shoring and bracing methods, and other means necessary to perform excavation. The Contractor shall be responsible for selecting the appropriate method of excavation and backfill. All excavation and backfilling work shall be maintained within the Project Limits where excavation and backfilling work is to occur. Shoring and bracing required for excavations shall conform to the requirements of this Section.
- H. Trenches excavated shall be no greater in width than is necessary to permit construction in accordance with the Contract Documents.

- I. Excavations up to, and in close proximity to, existing improvements and utilities shall require handwork to locate and identify crossing utilities and to properly excavate in constricted areas. Contractor shall not assume that all Work may be performed by backhoe or similar equipment.
- J. The Contractor shall use concrete barriers (K-Rail) and/or fencing to barricade their Work from traffic during all trenching operations. When no active work is being performed for over 24 hours, open trenches and wharf openings not barricaded by K-Rail or fencing shall be covered by steel plates as required in this Section.
- K. If the Contractor encounters unidentified Stained or Odorous Material or VOC-Contaminated Soil, Contractor shall stop Work in that work area and notify the Engineer immediately. Contractor shall not resume earthwork in that work area until directed by the Engineer. Contractor shall not collect samples from that work area without Engineer's review of the Contractor's proposed plan for sampling, testing, and segregating such soil. Contractor shall provide the Engineer with a minimum of two (2) Working Days advance notice of scheduled sampling in order for the Engineer to have the opportunity to be present during sampling.
- L. At the direction of the Engineer, the Contractor shall excavate, segregate, stockpile, test, characterize, profile, load, haul, and dispose of Soil determined to be geotechnically unsuitable, Stained or Odorous Material, and/or VOC-Contaminated Soil per the requirements of this Section.

3.03 SHEETING, SHEETPIILING, BRACING, SHORING, OR OTHER SUPPORT SYSTEMS

- A. Contractor's design and construction of all required support systems shall consider Soil and Groundwater conditions. Work shall be performed in accordance with the Contract Documents and Contractor's staging of work, and shall be installed and removed without damage to Contractor's Work or items to be protected in place. The Contractor shall repair any damage caused by installation and removal of support systems at no additional cost to the City.
- B. The geotechnical design parameters and data required to design support systems must be determined by the Contractor.
- C. General Requirements:
 - 1. The Contractor shall provide adequate sheeting, shoring, bracing, or equivalent method for the protection of life and limb and existing facilities, which shall conform to applicable Federal and State safety orders.
 - 2. Before beginning any excavating or trenching of five (5) feet or more in depth, the Contractor shall prepare and submit to the Engineer a detailed plan showing the design of shoring, bracing, or other provisions to be made for protection of workers and existing facilities from the hazard of caving during excavation. The Contractor's proposed plan shall comply with the standards established by the U.S. Government and State of California Construction Safety Orders and be prepared by a Civil or Structural Engineer registered in the State of California, who shall sign and stamp said drawings.

3. Review of any excavation support system by the Engineer shall not relieve the Contractor of the obligation to comply with Construction Safety Order Standards for the design and construction of such protective work.

D. Design:

1. Contractor shall submit engineering calculations, stamped by a Civil or Structural Engineer registered in the State of California, for the design of the support system as required to support the sides and ends of excavations to prevent soil movement and water intrusion.
2. Contractor is solely responsible for the adequacy and design of the support system.
3. The excavation support system and all components to support the earth pressures, utility loads, equipment, applicable traffic and construction loads, and other surcharge loads, shall be designed in such a manner to allow the safe and expeditious excavation without movement or settlement of the adjacent ground, and shall prevent damage to or movement of adjacent facilities.
4. Each member of the excavation support system shall be designed to support the maximum loads that can occur during excavation. The design load means the maximum load the support member will be designed to carry.
5. The excavation support systems shall be designed for staged removal to conform to excavation and backfill sequence.

E. Installation:

1. Contractor shall furnish, place, and maintain such support system, as designed to support the sides and ends of excavations and prevent Soil movement.
2. The bottoms of support system elements shall be carried to a depth below the excavations adequate to prevent lateral and vertical movement of the support system.
3. Sheet piling, if used, shall be installed as the excavation progresses and in such a manner as to maintain pressure against the original ground at all times. The sheet piling shall be installed vertically with the edges tight together, and all bracing shall be of such design and strength to maintain the sheet piling in its proper position.
4. Vibratory installation of shoring and sheet piling shall not be allowed without Engineer's approval.

F. Removal:

1. In general, all sheet piling, sheet piling, bracing, shoring, or other methods used to support the sides of open excavations shall be withdrawn as the excavations are being backfilled and compacted.

2. Contractor shall not remove the support system until the Work has attained the required strength to permit the placing of Backfill Material.
3. Vibratory removal of shoring and sheeting shall not be allowed.

3.04 STOCKPILE CONSTRUCTION

- A. Contractor shall establish separate stockpiles for each type of Soil or Waste. Soil or Waste with different characterizations shall be segregated without mixing or comingling with adjacent stockpiles.
- B. Contractor shall manage Waste and Soil stockpiles to complete the Work as specified in the Contract Documents. Any and all delays associated with improper management of stockpiles shall be at no additional cost to the City.
- C. Contractor shall construct stockpile(s) on a level surface. All stockpile locations proposed by the Contractor shall be reviewed by the Engineer. Each completed stockpile shall be finished to a uniform shape and the top shall be sloped at a minimum grade of two percent (2%) to provide drainage.
- D. Contractor shall install fencing around Waste stockpiles. Fencing shall be temporary chain link, minimum six-feet in height, set on freestanding bases secured by sand bags or equal for stability and wind resistance, with windscreen installed on the entirety of the fence. Stockpile fencing shall be labeled to correspond with representative samples submitted for laboratory testing for Soil characterization purposes as presented in this Section.
- E. As required by the Contractor's Removal, Storage, Transportation and Disposal Work Plan, Contractor shall provide engineering measures for odor, vapor, and dust control. Contractor shall comply with SCAQMD Rule 402 (odor and nuisance), Rule 403 (fugitive dust), and Rule 1166 (vapors).
- F. Contractor shall contain and manage water draining from stockpiles as Liquid Waste.
- G. Contractor shall underlay each Waste stockpile with 10-mil plastic sheeting with minimum eighteen (18) inch overlap of individual sheets. Plastic sheeting shall be anchored with sandbags. Any damage to the plastic sheeting shall be repaired within 24 hours at no additional cost to the City. The damaged area shall not be covered before the repair is observed and accepted by the Engineer.
- H. Contractor shall cover each stockpile at the end of each day, or when a stockpile has reached the maximum height allowed per the Drawings and as required per the conditions of the Contractor's BMP Checklist.
- I. Base Material encountered during excavation shall be removed and stockpiled separately from other Soil without comingling. Stockpiled Base Material to be disposed offsite shall be tested, characterized, profiled, and disposed offsite as a Waste per the requirements of this Section. Stockpiled Base Material to be reused shall conform to the requirements of SECTION 32 11 00, "BASE COURSES".
- J. Contractor shall stockpile Surplus Soil separately from other Waste, which shall be managed within the Project Limits identified on the Drawings. Surplus Soil

shall be stockpiled for potential use as Backfill Material within the Project Limits. Unused Surplus Soil shall be tested characterized, profiled, and disposed offsite per the requirements of this Section.

- K. Contractor shall conduct SCAQMD Rule 1166 air monitoring at the stockpiles. The Contractor shall maintain the stockpiles and provide mitigation measures in accordance with SCAQMD Rule 1166. VOC-Contaminated Soil shall be segregated and stockpiled separately from all other materials by the Contractor. The total quantity of stockpiled VOC-Contaminated Soil shall not exceed the limit stipulated by SCAQMD Rule 1166.
- L. Stockpile area(s) shall be managed in accordance with the Contractor's BMP Checklist.

3.05 EXISTING UNDERGROUND UTILITIES (KNOWN)

- A. Locations of utilities shown on Drawings are provided for the Contractor's information only and the Contractor shall be responsible for verifying the location of said utilities.
- B. Contractor shall protect known existing utilities, including those shown on the Drawings to remain, and will be held responsible to repair damage resulting from Contractor's failure to protect these facilities adequately. Damage to known utilities caused by the Contractor shall be repaired or replaced by the Contractor within the same day in accordance with standards of utilities and agencies having jurisdiction, at no additional cost to the City.
- C. Contractor shall coordinate all work near utilities with the Engineer and utility owners. Contractor shall cooperate with the Engineer and utility owners in maintaining service.

3.06 EXISTING UNDERGROUND UTILITIES (UNKNOWN)

- A. When previously unknown utility lines are encountered within the area of operations, the Contractor shall notify the Engineer. Contractor shall protect the utility lines until the Engineer notifies the Contractor of the required course of action. Protection of utilities shall be per the Contract Documents.
- B. Contractor shall not disrupt a service until required action on such lines has been determined by the Engineer.

3.07 EXCAVATION NEAR GAS LINES AND FIBER OPTIC LINES PER GOVERNMENT CODE 4216

- A. If an excavation is within the tolerance zone of a gas line or fiber optic line, Contractor shall determine the exact location of the line using hand tools before using any power-driven equipment in the tolerance zone. Contractor shall use reasonable care to prevent damaging gas lines and fiber optic lines.
 - 1. "Tolerance Zone" is defined as 24 inches on each side of the field marking placed by the operator or marking service in one of the following ways:

- a. 24 inches from each side of a single marking, assumed to be the centerline of the subsurface installation.
 - b. 24 inches plus one-half the specified size on each side of a single marking with the size of installation specified.
 - c. 24 inches from each outside marking that graphically shows the width of the outside surface of the subsurface installation on a horizontal plane.
- B. Contractor may use a vacuum extraction device to expose subsurface installations within the tolerance zone if the operator has marked the gas or fiber optic line, the Contractor has contacted the line owner/company whose installations may be in conflict with the excavation, and the operator has agreed to the use of a vacuum excavation device. Contractor shall inform the regional notification center of Contractor's intent to use a vacuum excavation device when obtaining the ticket.
- C. Contractor may use power-operated or boring equipment for the removal of any existing pavement only if there is no known subsurface installation contained in the pavement.
- D. Contractor shall presume all subsurface installations to be active, and shall use the same care around subsurface installations that may be inactive as the Contractor would use around active subsurface installations.

3.08 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavation consists of removal of Soil beyond limits specified herein and shown on the Drawings.
- B. Unauthorized excavations shall be backfilled and compacted at no additional cost to the City as specified for adjacent authorized excavations, unless otherwise directed by Engineer.

3.09 IMPORT AND EXPORT

- A. Import Soil shall be brought to the Site in accordance with Contractor's Import and Export Soil Hauling Plan and the requirements and procedures of this Section.
- B. Contractor shall provide truckers with handouts that indicate approved haul routes.
- C. The form of "Certificates of Weights and Measures" (load ticket) used shall be subject to approval or change at the beginning of the Contract to conform to the requirements of the City, and the Contractor shall be responsible for the accuracy thereof. The Contractor shall keep all records of gross, tare, and net weights in detail. The load ticket of each truck shall be delivered with each load. Tickets shall identify the origin location of the material. All trucks shall be plainly numbered.
- D. All records of gross, tare, and net weights shall be signed by a California Licensed Weighmaster.

- E. Contractor's equipment hauling material to or from the Work Site shall not queue on streets within the City of Long Beach without prior approval of the Engineer.
- F. Contractor's trucks to be loaded at the Work Site shall only access the Work Site through the designated ingress and egress in accordance with the Contract Documents.
- G. Full-time flagperson shall be provided by the Contractor at the Work Site gates in accordance with the Contract Documents and as approved by the Engineer.
- H. Contractor's truck traffic shall be included in the Traffic Control Plan submitted to the Engineer to minimize traffic impacts within the terminal, at the Work Site gate, and on surrounding surface streets, and reduce dust generation during import and hauling work.

3.10 SUBGRADE PREPARATION

- A. Contractor shall prepare subgrade in conformance with SSPWC Section 301-1.2, Preparation of Subgrade, except that prior to placing base material, the Contractor shall scarify and recompact the top eighteen (18) inches of subgrade to ninety-five percent (95%) of Modified Proctor Dry Density (ASTM D1557), and shall grade subgrade to lines and elevations indicated on the Drawings.
- B. Contractor shall notify the Engineer in writing three (3) Working Days in advance of performing any work for the subgrade preparation.
- C. Contractor shall notify the Engineer two (2) Working Days in advance for subgrade observation and acceptance by the Engineer. Contractor shall not place any utility, structure or pavement, including bedding or base, on subgrade without the Engineer's prior acceptance of subgrade.
- D. Contractor shall not operate equipment supported directly on the subgrade unless the equipment selected can be supported without softening of the subgrade, as accepted by the Engineer.
- E. Contractor shall not place Bedding or Backfill Material on surfaces that are unstable or "pumping" as determined by the Engineer. If the Engineer determines that Contractor's methods are inappropriate to prepare the subgrade or the Engineer determines an unstable or "pumping" surface exists, then subgrade stabilization measures will be as determined and directed by the Engineer.
 - 1. Soft or pumping subgrades shall be stabilized by over-excavating the subgrade up to twenty-four (24) inches, and placing and compacting 3/4-inch crushed rock in the over-excavated area.
 - 2. Soft or pumping subgrades within utility trenches could be alternatively stabilized by over-excavating the subgrade twelve (12) inches, and placing one-sack concrete slurry in the over-excavated area.

3.11 BEDDING

- A. Contractor shall place Bedding Material in conformance with SSPWC Section 306-1.2.1, and the requirements shown in the Contract Documents.

- B. Jetting of Bedding shall not be allowed, unless approved by the Engineer.

3.12 BACKFILLING

- A. Prior to placement of Backfill Material, Contractor shall remove all organic matter, rocks greater than three (3) inches in any dimension, trash, steel, wood, concrete, asphalt concrete, and other unsatisfactory material from placement area.
- B. Contractor shall place Backfill Material as Work permits, but not until completion of the following:
 - 1. Acceptance by the Engineer of Work below finish grade.
 - 2. Inspection by any third party utility owner of their utility.
 - 3. As-built survey and recording of as-built survey on the Project Record Documents by Contractor of final location (Northing and Easting coordinates and elevation), and limits of any excavation, structure, utility, and other underground feature, new and existing, that will be covered by Backfill Material, including as applicable, all utility terminations, utility appurtenances, water line valves and fittings, and changes in grade for utility lines.
 - 4. Removal of concrete formwork, trash, and debris.
- C. Contractor shall remove shoring and bracing as appropriate to facilitate placement of Backfill Material but shall maintain safe and stable excavations at all times.
- D. Placement of Backfill Material by the Contractor shall be in conformance with SSPWC Sections 306-1.3.1 and 306-1.3.2, and the requirements shown in the Contract Documents.
- E. Unless otherwise specified, Contractor shall place Backfill Material in horizontal layers not exceeding eight (8) inches in loose thickness prior to compaction. The Engineer will perform compaction testing in conformance with this Section.
- F. Contractor shall not begin backfill and compaction of trenches containing utilities encased in concrete until a minimum of twenty-four (24) hours after placing the concrete encasement and observation by the Engineer.

3.13 COMPACTION AND DENSITY CONTROL

- A. Contractor shall properly compact excavation subgrades and Backfill Material to achieve the following requirements, and correct any deficiencies resulting from insufficient and improper compaction of such materials at no additional cost to the City:
 - 1. Ninety percent (90%) of Modified Proctor Dry Density (ASTM D1557) for all excavation subgrades.

2. In areas under pavement and structures, ninety-five percent (95%) of Modified Proctor Dry Density (ASTM D1557) for Backfill Material.
 3. Ninety-five percent (95%) of Modified Proctor Dry Density (ASTM D1557) for Structure Backfill Material placed within five (5) feet of structures.
 4. In areas not specified, ninety percent (90%) of Modified Proctor Dry Density (ASTM D1557) for Backfill Material.
 5. The minimum moisture content for sandy soils used as Backfill Material shall be maintained at the optimum moisture content in accordance with ASTM D1557.
 6. The minimum moisture content for clayey soils used as Backfill Material shall be maintained at optimum plus two percent (2%) in accordance with ASTM D1557.
- B. The Engineer will perform density testing to certify that compaction meets the requirements of this Section. When tests are performed, acceptable results shall indicate that the compaction and density requirements specified in this Section have been obtained.
- C. The Engineer will perform density testing on each layer of Bedding and Backfill Material prior to placing succeeding layers. The number of tests performed shall be a minimum of one (1) for every two hundred (200) cubic yards of compacted material, with a minimum of one (1) test for every one (1) foot thickness of compacted material. Testing frequency shall be in accordance with ASTM methods, unless otherwise specified in this Section. The Engineer reserves the right to perform compaction tests in any location at any time. Retests of failed tests will be performed by the Engineer and costs for each retest may be deducted from the final payment to the Contractor. The Contractor shall provide space and allow time for each test to be performed and the results obtained.
- D. Contractor shall furnish assistance to facilitate density testing by the Engineer.
- E. The following tests may be used by the Engineer for on-site density control:
1. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil In-Place by the Sand Cone Method.
 2. ASTM D6938, - Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).
- F. Whenever the Contractor's operations do not conform to the above criteria and requirements contained in this Section, the Engineer will prohibit placement of an overlying lift until the Contractor takes effective corrective action at no additional cost to the City, including, but not limited to, scarification, manipulation of moisture, and re-compaction. Any delays resulting from the Contractor's corrective actions shall be at no additional cost to the City.
- G. Damage to any compacted lift at any time during the course of construction, such as rutting under loads imposed by earth moving equipment, shall be fully repaired and re-compacted to specified density at no additional cost to the City prior to placement of any overlying materials. Any delays resulting from the Contractor's corrective actions shall be at no additional cost to the City.

3.14 MOISTURE CONTROL

- A. Backfill Material may require addition of moisture, or may contain excess moisture in its natural state or may take on excess moisture during handling and stockpiling. The Contractor shall process material to attain specified moisture content, prior to compaction, at no additional cost to the City.
- B. Where Backfill Material is to be moisture conditioned before compaction, the Contractor shall uniformly apply potable water to surface of layer of placed Backfill Material and mix uniformly in such a manner as to prevent free water from appearing on surface during and subsequent to compaction operations.
- C. The Contractor shall remove and replace, or scarify and stir dry, Backfill Material that is too wet to permit compaction to specified density. Drying of Backfill Material shall be at no additional cost to the City. Any delays resulting from the Contractor's corrective actions shall be at no additional cost to the City.
- D. Material that is too wet to permit compaction may be temporarily stockpiled on-site within the Project Limits, spread, and allowed to dry. The Contractor shall assist drying by using one or a combination of methods including discing, harrowing, and pulverizing, until moisture content is reduced to a satisfactory value, as determined by moisture-density testing. Any moisture conditioning required shall be at no additional cost to the City.

3.15 WORKING ADJACENT TO EXISTING STRUCTURES

- A. The Contractor shall use caution when working adjacent to existing structures to assure they are not damaged. Damage to existing structures shall be repaired within 24 hours at no additional cost to the City.

3.16 PAVEMENT RESTORATION

- A. Pavement restoration shall be in accordance with the Contract Documents, SECTION 32 11 00, "BASE COURSES", and SECTION 32 12 16, "ASPHALT PAVING".

3.17 SOIL AND WASTE CHARACTERIZATION

- A. Contractor shall characterize the Soil and Waste stockpiles to determine disposition per the requirements of this Section.
- B. Under the supervision of the Contractor's Licensed Environmental Professional, the Contractor shall collect representative Soil samples from stockpiled Soil in accordance with the frequency provided below. These sampling frequencies shall apply to the total Soil volume for each individual stockpile of each Soil, VOC-Contaminated Soil, or Stained or Odorous Material. Samples shall be collected per the requirements specified herein.
 - 1. For each stockpile with a total volume of 500 cubic yards or less, the Contractor shall collect three (3) primary samples.
 - 2. For each stockpile with a total volume greater than 500 cubic yards, the Contractor shall collect three (3) primary samples for the first 500 cubic yards and one (1) primary sample for each 1000 cubic yards thereafter.

- C. Each Soil sample submitted for testing shall be collected at approximately three (3) feet below the surface of stockpile or at the mid-point of stockpile height, whichever is less. Each sample shall be collected at a randomly selected point on the stockpile surface in accordance with USEPA's "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods" (SW-846; most recent version). Composite soil sampling shall be prohibited. For VOCs and TPH in the gasoline range analysis, the Soil samples collected shall be sub-sampled in the field in accordance with USEPA Method 5035 and submitted separately for analysis.
- D. For quality control purposes, duplicate Soil samples shall also be collected and analyzed at a frequency of ten percent (10%) of the number of primary samples identified in this Section. Duplicate Soil samples shall be represented by collection of an additional sample immediately below one of the primary samples and analyzed by the same USEPA methods conducted for the primary samples. For VOCs and TPH in the gasoline range analysis, a subsample of the Soil immediately below the primary sample shall be collected in accordance with USEPA Method 5035 and analyzed. The number of duplicate Soil samples shall be rounded up to the next whole number; a minimum of one (1) duplicate sample is required. For VOC analysis, trip blanks shall be analyzed for each sampling event.
- E. Contractor's Soil and Liquid Waste sampling and handling procedures shall be in accordance with USEPA's "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods" (SW-846; most recent version). Soil and Liquid Waste samples shall be transferred to laboratory-quality sample containers and preserved in accordance with SW-846. Each Waste sample shall be recorded and transported using an approved chain-of-custody form.
- F. Contractor shall sample and test stockpiled Soil within three (3) Working Days of the completion of Soil excavation of each Waste characterization or when a stockpile reaches its maximum size or height, per the requirements of this Section.
- G. Contractor shall request laboratory turn-around time sufficient to meet its contractual schedule; however, in no case shall the turn-around-time exceed seven (7) calendar days. If required to meet the Project schedule milestones, Contractor shall expedite laboratory analysis at no additional cost to the City. Any and all delays associated with Contractor's laboratory testing shall be at no additional cost to the City.
- H. Laboratory analysis of each Soil sample shall be performed by the Contractor's environmental testing laboratory per the requirements of this Section and in accordance with the table below:

Analysis Type	Method Number
TPH as carbon chain	USEPA Method 8015M/5035. [For TPH analysis with carbon-range distinction, a portion of the sample shall be preserved using USEPA Method 5035 to be analyzed for the gasoline-range fraction]
VOCs	USEPA Method 8260B/5035
PCBs	USEPA Method 8082
PAHs	USEPA Method 8310
OCPs	USEPA Method 8081A
California Code of Regulations, Title 22 Metals (17 metals)	USEPA Method 6010B/7470A
Note: If reported TTLC for an analyte exceeds ten times (10x) the regulatory maximum for the enforceable California STLC and/or twenty times (20x) the regulatory maximum for the enforceable Federal soluble concentration per TCLP, the appropriate leachability test(s) shall be conducted by the Contractor at no additional cost to the City.	

3.18 WASTE DISPOSITION

- A. The preliminary disposal Waste characterizations for offsite disposal of Waste, per the Contract Documents, are as follows:
 1. Non-Hazardous Waste.
- B. Contractor shall identify offsite disposal facilities from the list presented in this Section for final disposition of all Waste identified in this Section. The Engineer shall have approval authority for the final disposition of Waste. As part of the approval process, the Contractor shall submit completed Waste Profile applications and sample manifests from the disposal facilities to the Engineer for review and approval by the Engineer within no more than fourteen (14) calendar days from submittal of the Waste Characterization Report. Contractor shall submit copy(ies) of the Profile approval(s) from the Contractor's selected disposal facility(ies).
- C. Contractor shall provide sufficient numbers of Waste manifests for the transport of all Waste to the offsite facility(ies). The Engineer will obtain the authorized signatures on the manifests provided by the Contractor and will retain all copies of the manifests until the Contractor is authorized to dispose of the Waste. Contractor shall obtain signed manifests from the Engineer for each load prior to the load being transported offsite. The City shall not be responsible for additional costs incurred should the Contractor fail to provide sufficient manifest forms for all Waste to be transported and disposed of offsite.
- D. After approval of a Waste profile by the Contractor's recycling or disposal facility, if random sampling of the Waste stream by the facility upon delivery indicates that the Waste exceeds the approved Profile, the Contractor shall immediately notify the Engineer.
- E. Contractor shall transport and dispose of Waste to specified and approved, licensed offsite disposal facilities within no more than ten (10) Calendar Days of Profile Approval.

- F. Contractor shall affix labels to all Waste containers (including drums, roll-off bins, and tanks). Contractor shall provide durable water-resistant labels with sufficient print size to be clearly legible, with bold print on a contrasting background, displaying the following:

CAUTION: CONTAINS (Type of Non-Hazardous or Hazardous Waste)
DATE: _____ SOURCE: _____
Contractor Name: _____ Phone No.: _____
USEPA ID No.: _____ (if applicable) _____
California ID No.: _____ (if applicable) _____

3.19 WASTE DISPOSAL FACILITIES

- A. Contractor shall transport and dispose of Waste to specified and approved, licensed offsite disposal facilities for final disposition per the Contract Documents.
- B. For each Waste category, prior to bidding, Contractor shall confirm that one or more of the facilities that the Contractor is selecting from the approved Landfills and Recycling Facilities listed below, are capable, willing, and able to accept the Waste. Furthermore, at the time of disposal, the Contractor's proposed disposal facilities, from the approved Landfills and Recycling Facilities listed below, shall be fully licensed and permitted at the time of use and not subject to regulatory investigation or undergoing review for renewal of its license. Waste characteristics and circumstances at the time of disposal may dictate acceptance of the Waste at any specific facility and, in the case of rejection at any one facility, Contractor shall be responsible for arranging for disposal of the Waste at one or more of the remaining facilities at no additional cost to the City.
- C. The table below presents approved offsite facilities for lawful recycling and/or disposal of Soil characterized as Non-Hazardous Waste. Should the proposed facility or facilities be found to be unacceptable to the Engineer at the Engineer's exclusive discretion, an alternate facility or facilities from the table below shall be submitted for acceptance as a substitute at no additional cost to the City. Should Contractor wish to propose a facility not listed herein, Contractor shall submit Waste Profile applications for one or more licensed facilities that accept Soil characterized as Non-Hazardous Waste for review and approval by the Engineer.
- D. Contractor shall submit Waste profile applications for one or more licensed facilities that accept Liquid Waste characterized as Non-Hazardous Waste or Hazardous Waste for review and approval by the Engineer. The table below presents approved offsite facilities for lawful recycling and/or disposal of Liquid Waste characterized as Non-Hazardous Waste or Hazardous Waste. Should the proposed facility or facilities be unacceptable to the Engineer at the Engineer's exclusive discretion, an alternate facility or facilities from the table below shall be submitted for acceptance as a substitute at no additional cost to the City.

3.20 TRUCK LOADING AND HAULING FOR OFFSITE DISPOSAL OF WASTE

- A. While Waste is being loaded into trucks at the point of loading, the Contractor shall perform vapor, odor, and dust suppression in accordance with this Section and SCAQMD Rule 1166. After the Waste is loaded into the transport trucks, the Waste shall be covered and otherwise contained to prevent Waste from blowing or spilling out of the truck during transport to the Contractor's selected disposal facilities for final disposition.

- B. Prior to leaving the loadout area, all vehicles shall be decontaminated per the following conditions:
 - 1. All truck exteriors shall be broom cleaned after loading.
 - 2. The dump truck or roll-off bin portion of the truck shall be covered with a tarp to prevent Waste and/or dust from spilling out of the truck during transport to the Contractor's selected facilities for final disposition.
 - 3. For transportation of Hazardous Waste, the Contractor shall use an on-site wheel washing facility to remove loose Waste and/or dust from the underside and wheels of each truck and trailer. Wheel wash water shall be containerized, tested, profiled, and disposed of at an offsite facility as a Liquid Waste per the requirements of this Section. The wheel washing facility shall be specified in the Contractor's Removal, Storage, Transportation, and Disposal Work Plan Submittal.
- C. Prior to leaving the loadout areas, each truck shall be inspected by the Contractor to ensure that the payloads are adequately covered, the trucks are cleaned of spilled material, and the shipment is ready for transport. The Contractor shall obtain a signed manifest from the Engineer for each load prior to the load being transported offsite. Proper Hazardous Waste placarding shall be required for transportation of Hazardous Waste.
- D. The Contractor shall notify the Engineer a minimum of three (3) Working Days prior to truck loading and hauling so that the Engineer can be present during such operations.

3.21 WASTE DOCUMENTATION

- A. Contractor shall track on Non-Hazardous Waste Manifests, the movement from Project Site to approved offsite disposal facilities for final disposition of Waste characterized as Non-Hazardous Waste.
- B. Before offloading its payload, the truck shall be weighed by the disposal facility operator. Contractor shall provide manifests and certified load or weight tickets or bills of lading to the Engineer within 24 hours after the Waste has been transported offsite.

PART 4 – MEASUREMENT AND PAYMENT

- A. Measurement for "*Shoring for Excavations*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals and testing necessary for designing, furnishing, placing, maintaining, moving, and removing excavation sheeting, shoring, bracing or other required methods to provide adequate worker protection from the hazard of caving ground during demolition, construction and installation work requiring excavation and trench excavation, as specified and shown.
- B. Measurement for "*¾ -inch Crushed Rock*" will be by the Ton based on certified load tickets. One Ton equals 2,000 pounds. Payment for "*¾ -inch Crushed Rock*" will be as stated in the Schedule of Bid Items, and shall constitute full compensation to furnish all transportation, labor, materials, equipment, and incidentals, including hauling, stockpiling, placing, compacting, grading, and all

other work necessary for constructing $\frac{3}{4}$ -inch crushed rock bedding, as specified and shown.

- C. Measurement for "*Soil Excavation and Stockpiling of Non-Hazardous Waste*" will be by the Cubic Yard (CY) based on stockpile volume. Payment for "*Soil Excavation and Stockpiling of Non-Hazardous Waste*" will be as stated in the Schedule of Bid Items, and shall constitute full compensation to furnish all transportation, labor, materials, equipment, and incidentals necessary for excavating, segregating, stockpiling, sampling, testing, and characterizing Waste as specified and shown.
- D. Measurement for "*Disposal of Non-Hazardous Waste*" will be by the Ton based on certified load tickets. One Ton equals 2,000 pounds. Payment for "*Disposal of Non-Hazardous Waste*" will be as stated in the Schedule of Bid Items, and shall constitute full compensation to furnish all transportation, labor, materials, equipment, and incidentals necessary for profiling, loading, hauling, and disposing Waste, as specified and shown. Measurement and payment for this bid item will not include Liquid Waste.
- E. Measurement for "*Excavation*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery, and disposal, as required for trenching, shoring, backfill, compaction, and crushed rock, as specified and shown.
- F. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 32 11 00

BASE COURSES

PART 1 – GENERAL

1.01 SUMMARY OF WORK

- A. Contractor shall stockpile, haul, mix, and place City-furnished Crushed Miscellaneous Base (CMB) from the POLB Rubble Sites for pavement base course and other related Work as indicated on the Drawings and as specified.
- B. Section Includes:
 - 1. Work within the lines and grades established in the Drawings.

1.02 REFERENCES

- A. Standard Specifications - The Standard Specifications of the State of California, Business and Transportation Agency, Department of Transportation, latest edition.
- B. American Society for Testing and Materials (ASTM): ASTM C136, Standard Test Method for Sieve Analysis of Fine and Course Aggregates.
- C. Standard Specifications for Public Works Construction (SSPWC) – “Greenbook”, latest edition.

1.03 QUALITY ASSURANCE

- A. Testing of base course may be performed by the Engineer's testing laboratory. Contractor shall not place base course until test results, if conducted, have verified compaction of the subgrade soil.
- B. Import, export, and reuse materials shall comply with Environmental Requirements for Soil and Fill Material (see Section 31 00 00 EARTHWORK).

1.04 SUBMITTALS

- A. Submit to the Engineer list of equipment to be used for hauling, dust control during hauling, and placing crushed miscellaneous based (CMB) prior to usage in the job.
- B. Submit the CMB Removal Authorization Form at a minimum of two working days in advance of an anticipated pickup, Per Appendix P: POLB Rubble Site.

1.05 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Place aggregate base only when ambient temperature is above 40 degrees F and subgrade is dry.

1.06 REGULATORY REQUIREMENTS

- A. Contractor shall carry out the Work in conformance with applicable laws, codes, ordinances, and regulations of regulatory agencies having jurisdiction, including the furnishing of any required excavation drawings to the regulatory agencies and the obtaining of permits.
- B. Contractor shall comply with requirements of the SCAQMD Rule 403 on Fugitive Dust.

PART 2– PRODUCTS

2.01 CRUSHED MISCELLANEOUS BASE

- A. The City will furnish and load CMB without charge at the POLB Rubble Sites. Sizing of material as produced at crusher site or as directed by the Engineer. The Contractor is responsible for hauling, mixing, unloading and placing of CMB.
- B. Any imported material shall conform to SSPWC 200-2.2 and the Environmental Requirements for Soil and Fill Material requirements in Section 31 00 00 EARTHWORK.

PART 3– EXECUTION

3.01 PLACEMENT

- A. Equipment necessary for the satisfactory performance of this construction shall be on-site and subject to approval by the Engineer prior to beginning placement Work.
- B. The aggregate base course shall be spread, graded and compacted on the prepared subgrade in conformance with the lines, grades and dimensions shown in the Drawings, and shall conform to standard requirements for usual base course of this type for first class road work in accordance with the Standard Specifications for Public Works Construction – Greenbook – Section 301-1.
- C. Aggregate base shall be deposited and spread without segregation of aggregate and each layer shall be free from pockets of coarse or fine materials. Any such pockets shall be reworked to give a uniform layer.

- D. Contractor shall plan out work to avoid surplus. Base course shall be placed to an elevation tolerance of $\pm 0.05'$.
- E. Contractor shall place Crushed Rock in horizontal layers not exceeding eight (8) inches in loose thickness and compacted to a firm base, or as otherwise directed by the Engineer.
- F. Subgrade and base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with gravel. Materials spilled outside pavement lines shall be removed and area repaired.
- G. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise injured, shall be cleaned, replaced, or otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

3.02 COMPACTION

- A. Immediately following spreading and shaping, the Contractor shall compact each layer to at least 95 percent of the Modified Proctor Dry Density (ASTM D 1557) before the next succeeding layer is placed thereon.
- B. Vibratory compactors and rollers shall obtain the specified density for each layer while still moist. Contractor shall apply a mist spray of water, as needed, to replace moisture lost by evaporation. The completed layer shall have a smooth, tight, and uniform surface true to the line, grade, and cross-section as indicated on the Drawings, and as specified by the Engineer.
- C. Variations in the surface of the top course shall be a maximum of 0.04 feet in 10 feet. Contractor shall repair variations greater than the allowable and recompact that area.
- D. Surface Maintenance: Contractor shall maintain the surface of each layer of material true to line, grade, and cross-section by blading, watering, and rolling until placing the succeeding course.
 - 1. Contractor shall place first course of material on available subgrade before placing the succeeding course, unless otherwise authorized by the Engineer.
 - 2. Should irregularities develop in a surface after compaction, the Contractor shall correct the irregularity by loosening the surface, correcting the defects, and thoroughly recompact the entire area, including the surrounding surface.
 - 3. In the event that additional materials are necessary to make the repairs, the Contractor shall make the repairs at no additional cost to the City.
- E. Hauling over the CMB surface during the process of construction will not be permitted when, in the opinion of the Engineer, the effect will be detrimental.

3.03 FIELD QUALITY CONTROL

- A. Contractor shall notify the Engineer when base course or portion thereof has been placed and compacted in accordance with the requirements. Contractor shall not place pavement until approved by the Engineer.
- B. Compaction Control Testing:
 - 1. The Engineer will test each layer of compacted material for compliance with requirements specified before placement of succeeding layers.
 - 2. Compaction tests shall be performed in accordance with ASTM D 1557, ASTM D 2922 and ASTM D 3017.
 - 3. Compaction testing shall be performed on each layer prior to placing succeeding layers. The number of tests performed will be one per each 200 cubic yards of the compacted material.
 - 4. The Engineer will choose the test locations.

3.04 ADJUSTING

- A. If compaction tests indicate that base course does not meet specified requirements, the Contractor shall remove defective Work and replace. Retest costs will be the responsibility of the Contractor.

PART 4 – MEASUREMENT AND PAYMENT

- A. Base Courses as specified herein shall be included in the measurement and payment for "Concrete".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt overlay.
 - 3. Cold milling of existing asphalt pavement.
 - 4. Hot-mix asphalt patching.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Meeting: Conduct meeting at POLB Pump Shop.

1.03 REFERENCES

- A. Standard Specifications – State of California, California State Transportation Agency (Caltrans), latest edition.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. Herbicide.
- B. Job Mix Formula. Use Caltrans forms CEM 3511 and CEM 3512.
- C. Quality Control Plan
- D. Test Results. Use Caltrans form CEM 3512.

1.05 INFORMATIONAL SUBMITTALS

- A. Material Certificates:
 - 1. Aggregates.
 - 2. Asphalt binder.
 - 3. Tack coat.
- B. Asphalt Plant Certification
- C. Testing Laboratory Certification

- D. Quality Control Test Results

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Standard Specifications of California State Transportation Agency for HMA Type A asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 - PRODUCTS

2.01 AGGREGATES

- A. Provide aggregate conforming to the gradations and quality requirements of Caltrans HMA Type A for the following sizes:

2.02 ASPHALT MATERIALS

- A. Asphalt Binder: Caltrans Division 92 PG-70-10.
- B. Tack Coat: ASTM D977 emulsified asphalt, or ASTM D2397/D2397M cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- C. Surface Course: ½ inch

2.03 AUXILIARY MATERIALS

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
- B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

2.04 MIXES

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Caltrans HMA Type A

PART 3 - EXECUTION

3.01 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 1. Mill to a depth of 3 inches.
 - 2. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.

3.02 PATCHING

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.03 SURFACE PREPARATION

- A. Ensure that prepared subgrade is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.
- B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.04 HOT-MIX ASPHALT PLACEMENT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at a minimum temperature of 250 deg F.
 - 4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.05 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.06 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density, Rice Test Method: 91 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not greater than 97 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.07 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of 250 deg F.
 - 1. Hot-Mix Asphalt: Same as pavement surface-course mix.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.08 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: The city will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 WASTE HANDLING

- A. General: Handle asphalt-paving waste in accordance with approved waste management plan.

PART 4 - MEASUREMENT AND PAYMENT

- A. Asphalt Paving as specified herein shall be included in the measurement and payment for "Concrete".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes concrete paving including the following:

1. Roadways.

1.02 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.
- C. ACI: American Concrete Institute
- D. ASTM: American Society of Testing and Materials

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Meeting: Conduct meeting at POLB Pump Shop.
1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete paving Subcontractor.
 - e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals

- C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or epoxy adhesive.
 - 8. Joint fillers.
- C. Material Test Reports: For each of the following:
 - 1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- D. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.07 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Contractor to engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.08 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.02 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.03 STEEL REINFORCEMENT

2.04 REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from galvanized-steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
- E. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.
- F. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.
- G. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- H. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
- I. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
- J. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- K. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- L. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- M. Zinc Repair Material: ASTM A780/A780M.

2.05 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C150/C150M, gray portland cement Type II, Type V.

- B. Fly Ash: ASTM C618, Class F. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C260/C260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 2. Retarding Admixture: ASTM C494/C494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- E. Water: Potable and complying with ASTM C94/C94M.

2.06 FIBER REINFORCEMENT

- A. Synthetic Fiber, Monofilament Fibers: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches long.
- B. Synthetic Fiber, Fibrillated Fibers: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches long.

2.07 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

2.08 RELATED MATERIALS

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
- F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
 - 1. Color: As indicated by manufacturer's designation.
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.09 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash or Pozzolan: 25 percent.
 - 2. Slag Cement: 50 percent.
 - 3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content, 1-1/2-inch Nominal Maximum Aggregate Size: 5-1/2 percent plus or minus 1-1/2 percent.
 2. Air Content, 1-inch Nominal Maximum Aggregate Size: 4-1/2 percent plus or minus 1-1/2 percent.
 3. Air Content, 3/4-inch Nominal Maximum Aggregate Size: 5 percent plus or minus 1-1/2 percent.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture in concrete as required for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.
- G. Concrete Mixtures: Normal-weight concrete.
1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum W/C Ratio at Point of Placement: 0.45.
 3. Slump Limit: 4 inches, plus or minus 1 inch.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 INSTALLATION OF STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.
- G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.05 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 2. Provide tie bars at sides of paving strips where indicated.
 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.06 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.07 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.08 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by curing compound as follows:
 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.09 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 1. Elevation: 3/4 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch.
 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
 5. Lateral Alignment and Spacing of Dowels: 1 inch.
 6. Vertical Alignment of Dowels: 1/4 inch.
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
 8. Joint Spacing: 3 inches.
 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: The City will engage a qualified testing agency to perform tests and inspections.

- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results to be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.11 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.
- B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

PART 4 - MEASUREMENT AND PAYMENT

- A. Measurement for "*Concrete*" will be on a percentage of the Lump Sum bid for this item at the discretion of the Engineer in accordance with General Conditions GC-9.1.3. Payment shall include furnishing all transportation, labor, materials, equipment, incidentals, testing, permit fees, delivery as specified and shown.
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Joint-sealant backer materials.
 - 3. Primers.

1.02 DEFINITIONS

- A. ASTM: American Society of Testing and Materials

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Meeting: Conduct meeting at POLB Pump Shop.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. Concrete pavement joint sealants.
 - 2. Joint-sealant backer materials.
- B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.
- C. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.
 - 1. Size: Joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Paving-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For Installer.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.07 PRECONSTRUCTION TESTING

- ### **A. Preconstruction Testing:** Performed by a qualified testing agency.

1.08 FIELD CONDITIONS

- ### **A. Do not proceed with installation of joint sealants under the following conditions:**

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg Fahrenheit (F).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

- ### **A. Obtain joint sealants from single manufacturer.**

2.02 JOINT SEALANTS, GENERAL

- ### **A. Compatibility:** Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.03 COLD-APPLIED JOINT SEALANTS

- ### **A. Single-Component, Nonsag, Silicone Joint Sealant:** ASTM D5893/D5893M, Type NS.
- ### **B. Single-Component, Self-Leveling, Silicone Joint Sealant:** ASTM D5893/D5893M, Type SL

2.04 JOINT-SEALANT BACKER MATERIALS

- ### **A. Joint-Sealant Backer Materials:** Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.05 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

- C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backer materials.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
 - 3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. Remove excess joint sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.04 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.05 PAVING-JOINT-SEALANT SCHEDULE

- A. Joints within concrete paving:
 - 1. Joint Location:
 - a. Expansion and isolation joints in concrete paving.
 - b. Contraction joints in concrete paving.
 - c. Other joints as indicated.
 - 2. Joint Sealant: Single-component, nonsag, silicone joint or sealant Single-component, self-leveling, silicone joint sealant.

3. Joint-Sealant Color: Manufacturer's standard.

PART 4 - MEASUREMENT AND PAYMENT

- A. Concrete Paving Joint Sealants as specified herein shall be included in the measurement and payment for "Concrete".
- B. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION

SECTION 33 05 00

COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Piping joining materials.
 - 2. Transition fittings.
 - 3. Sleeves.
 - 4. Identification devices.
 - 5. Piped utility demolition.
 - 6. Piping system common requirements.
 - 7. Equipment installation common requirements.

1.02 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- C. ABS: Acrylonitrile-butadiene-styrene plastic.
- D. ASTM: American Society of Testing and Materials
- E. CPVC: Chlorinated polyvinyl chloride plastic.
- F. PE: Polyethylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Dielectric fittings.
 - 2. Identification devices.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.05 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 03 30 00 "CAST-IN-PLACE CONCRETE."

PART 2 - PRODUCTS

2.01 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D2235.
 - 2. CPVC Piping: ASTM F493.
 - 3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 - 4. PVC to ABS Piping Transition: ASTM D3138.

2.02 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 and Smaller:
 - 1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
 - 2. Aboveground Piping: Specified piping system fitting.
- C. AWWA Transition Couplings NPS 2 and Larger:
 - 1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Description: MSS SP-107, PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.
- F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
 - 1. Description: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.03 SLEEVES

- A. Mechanical sleeve seals for pipe penetrations are specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
- G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.04 IDENTIFICATION DEVICES

- A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.

- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 - 2. Location: Accessible and visible.
- C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
 - 1. Material: Fiberboard.
 - 2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
- F. Lettering: Manufacturer's standard preprinted captions as selected by Engineer.
- G. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
- H. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.
 - 1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 - 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- I. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
 - 1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

PART 3 - EXECUTION

3.01 PIPED UTILITY DEMOLITION

- A. Refer to Section 02 41 19 "SELECTIVE DEMOLITION" for general demolition requirements and procedures.

- B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to City.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the coordination drawings.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping at indicated slopes.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.
- G. Select system components with pressure rating equal to or greater than system operating pressure.
- H. Sleeves are not required for core-drilled holes.
- I. Permanent sleeves are not required for holes formed by removable PE sleeves.
- J. Verify final equipment locations for roughing-in.
- K. Refer to equipment specifications in other Sections for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- E. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
 - 3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix.
- F. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

3.04 EQUIPMENT INSTALLATION

- A. Install equipment level and plumb, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

3.05 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 - 1. Stenciled Markers: According to ASME A13.1.
 - 2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
 - 3. Locate pipe markers on exposed piping according to the following:
 - a. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
 - b. At manholes and similar access points that permit view of concealed piping.
 - c. Near major equipment items and other points of origination and termination.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
 - 1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for

- greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

PART 4 - MEASUREMENT AND PAYMENT

- A. Utility work related to plumbing, water, and sewer lines as specified herein shall be included in the measurement and payment for "Plumbing".
- B. Utility work related to fire suppression lines as specified herein shall be included in the measurement and payment for "Fire Alarm and Sprinklers".
- C. Utility work related to electrical distribution and communication lines as specified herein shall be included in the measurement and payment for "Electrical Distribution".
- D. Utility work related to electrical power supply as specified herein shall be included in the measurement and payment for "Electrical Power Supply".
- E. Utility work related to heating, ventilating, and air conditioning including natural gas lines as specified herein shall be included in the measurement and payment for "Mechanical".
- F. No separate measurement and payment will be made for any other work covered by this Section. The cost of any other work shall be considered incidental.

END OF SECTION