

## DOCUMENT 002113 - INSTRUCTIONS TO BIDDERS

**TIPS:**

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## 1.1 INSTRUCTIONS TO BIDDERS

- A. AIA Document A701, "Instructions to Bidders," is hereby incorporated into the Procurement and Contracting Requirements by reference.
  - 1. A copy of AIA Document A701, "Instructions to Bidders," is bound in this Project Manual.

END OF DOCUMENT 002113

## SECTION 012100 - ALLOWANCES

**TIPS:**

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## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
  - 1. Lump-sum allowances.
  - 2. Unit-cost allowances.
  - 3. Quantity allowances.
  - 4. Contingency allowances.
  - 5. Testing and inspecting allowances.
- C. Related Requirements:
  - 1. Section 012200 "Unit Prices" for procedures for using unit prices, including adjustment of quantity allowances when applicable.
  - 2. Section 014000 "Quality Requirements" for procedures governing the use of allowances for field testing by an independent testing agency.

## 1.3 DEFINITIONS

- A. Allowance is a quantity of work or dollar amount established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

#### 1.4 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

#### 1.5 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

#### 1.7 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include [taxes, ]freight[, ] and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
  - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

## 1.8 UNIT-COST ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include [**taxes**, ]freight[, ] and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
  - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

## 1.9 QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include [**taxes**, ]freight[, ] and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
  - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

## 1.10 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by Architect for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. Contractor's[ **overhead, profit, and** ] related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation[, **taxes**], insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

### 1.11 TESTING AND INSPECTING ALLOWANCES

- A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
- B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
- C. Costs of testing and inspection services not required by the Contract Documents are not included in the allowance.
- D. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to Owner by Change Order.

### 1.12 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
  - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
  - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
  - 3. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit-cost allowances.
  - 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
  - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
  - 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

## 3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

## 3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Quantity Allowance: Include 2000 cu. yd. (1529 cu. m) of unsatisfactory soil excavation and disposal off-site and replacement with satisfactory soil material from off-site, as specified in Section 312000 "Earth Moving."
  - 1. Coordinate quantity allowance adjustment with unit-price requirements in Section 012200 "Unit Prices."
- B. Allowance No. 2: Quantity Allowance: Include 1000 cu. yd. (765 cu. m) of rock removal and replacement with satisfactory soil material, as specified in Section 312000 "Earth Moving."
  - 1. Coordinate quantity allowance adjustment with unit-price requirements in Section 012200 "Unit Prices."
- C. Allowance No. 3: Lump-Sum Allowance: Include the sum of \$30,000 for three chandeliers for the main lobby as specified in Section [265113 "Incandescent Interior Lighting."] [265119 LED "Interior Lighting."]
  - 1. This allowance includes material cost, receiving, handling, and installation, and Contractor overhead and profit.
- D. Allowance No. 4: Unit-Cost Allowance: Include the sum of \$350.00 per thousand for buff-colored face brick as specified in Section 042000 "Unit Masonry" and as shown on Drawings.
- E. Allowance No. 5: Quantity Allowance: Include 5000 sq. yd. (4180 sq. m) of Carpet Type 1 installed, including urethane foam carpet cushion and related amount of tackless strip, as specified in Section 096816 "Sheet Carpeting."
- F. Allowance No. 6: Contingency Allowance: Include a contingency allowance of \$100,000.00 for use according to Owner's written instructions.

- G. Allowance No. 7: Testing and Inspection Allowance: Include the sum of \$1,000.00 for testing concrete to be provided by Owner as specified in Section 033000 "Cast-in-Place Concrete."
- H. Allowance No. <Insert number>: [**Lump-Sum**] [**Unit-Cost**] [**Quantity**] [**Contingency**] [**Testing and Inspecting**] Allowance: Include the sum of <Insert dollar or quantity amount of allowance>: Include <Insert allowance description> as specified in Section <Insert Section number> "<Insert Section title>" [ and as shown on Drawings].
1. This allowance includes [**material cost**] [**receiving, handling, and installation**] [**and**] [**Contractor overhead and profit**].
  2. Coordinate quantity allowance adjustment with corresponding unit-price requirements in Section 012200 "Unit Prices."

END OF SECTION 012100

## SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

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## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Startup construction schedule.
  - 2. Contractor's Construction Schedule.
  - 3. Construction schedule updating reports.
  - 4. Daily construction reports.
  - 5. Material location reports.
  - 6. Site condition reports.
  - 7. Unusual event reports.
- B. Related Requirements:
  - 1. Section 011200 "Multiple Contract Summary" for preparing a combined Contractor's Construction Schedule.

## 1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
  2. Predecessor Activity: An activity that precedes another activity in the network.
  3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which 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.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
1. Float time [**belongs to Owner**] [**is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date**].
  2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
  3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
1. Working electronic copy of schedule file, where indicated.
  2. PDF file.
  3. [**Two**] <**Insert number**> paper copies, of sufficient size to display entire period or schedule, as required.
- B. Startup construction schedule.
1. Submittal of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
  2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
  3. Total Float Report: List of activities sorted in ascending order of total float.
  4. Earnings Report: Compilation of Contractor's total earnings from **[commencement of the Work] [the Notice to Proceed]** until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at **[weekly] [monthly]** intervals.
- H. Material Location Reports: Submit at **[weekly] [monthly]** intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Unusual Event Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.
- 1.5 QUALITY ASSURANCE
- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
  2. Verify availability of qualified personnel needed to develop and update schedule.
  3. Discuss constraints, including **[phasing] [work stages] [area separations] [interim milestones] [and] [partial Owner occupancy]**.
  4. Review delivery dates for Owner-furnished products.
  5. Review schedule for work of Owner's separate contracts.
  6. Review submittal requirements and procedures.
  7. Review time required for review of submittals and resubmittals.
  8. Review requirements for tests and inspections by independent testing and inspecting agencies.

9. Review time required for Project closeout and Owner startup procedures[, **including commissioning activities**].
10. Review and finalize list of construction activities to be included in schedule.
11. Review procedures for updating schedule.

## 1.6 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values,[ **list of subcontracts,**] submittal schedule, progress reports, payment requests, and other required schedules and reports.
  1. Secure time commitments for performing critical elements of the Work from entities involved.
  2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

## 1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
  1. Use [**Microsoft Project,**] [**Primavera,**] [**Meridian Prolog,**] [**Scheduling component of Project website software specified in Section 013100 "Project Management and Coordination,"**] <Insert name of specific software,> for current [**Windows**] [**Macintosh**] operating system.
- B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
  1. In-House Option: Owner may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
  2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- C. Time Frame: Extend schedule from date established for [**commencement of the Work**] [**the Notice of Award**] [**the Notice to Proceed**] to date of [**Substantial Completion**] [**final completion**].
  1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- D. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
  1. Activity Duration: Define activities so no activity is longer than [**20**] <Insert number> days, unless specifically allowed by Architect.
  2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities

in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

- a. **<Insert list of major items or pieces of equipment>**.
  3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
  4. Startup and Testing Time: Include no fewer than [15] **<Insert number>** days for startup and testing.
  5. Commissioning Time: Include no fewer than [15] **<Insert number>** days for commissioning.
  6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's[ **and Construction Manager's**] administrative procedures necessary for certification of Substantial Completion.
  7. Punch List and Final Completion: Include not more than [30] **<Insert number>** days for completion of punch list items and final completion.
- E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
  2. Work under More Than One Contract: Include a separate activity for each contract.
  3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
  4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  6. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Coordination with existing construction.
    - b. Limitations of continued occupancies.
    - c. Uninterruptible services.
    - d. Partial occupancy before Substantial Completion.
    - e. Use-of-premises restrictions.
    - f. Provisions for future construction.
    - g. Seasonal variations.
    - h. Environmental control.
  7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
    - a. Subcontract awards.
    - b. Submittals.
    - c. Purchases.
    - d. Mockups.
    - e. Fabrication.
    - f. Sample testing.

- g. Deliveries.
      - h. Installation.
      - i. Tests and inspections.
      - j. Adjusting.
      - k. Curing.
      - l. Building flush-out.
      - m. Startup and placement into final use and operation.
      - n. Commissioning.
  8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
    - a. Structural completion.
    - b. Temporary enclosure and space conditioning.
    - c. Permanent space enclosure.
    - d. Completion of mechanical installation.
    - e. Completion of electrical installation.
    - f. Substantial Completion.
  9. Other Constraints: **<Insert constraints not indicated elsewhere>**.
- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion[.][, **and the following interim milestones:**]
1. Temporary enclosure and space conditioning.
  2. **<Insert milestones not indicated elsewhere>**.
- G. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- H. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
  2. Unanswered Requests for Information.
  3. Rejected or unreturned submittals.
  4. Notations on returned submittals.
  5. Pending modifications affecting the Work and the Contract Time.
- I. Contractor's Construction Schedule Updating: At [**monthly**] **<Insert time>** intervals, update schedule to reflect actual construction progress and activities. Issue schedule [**one week**] **<Insert time>** before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.

2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  3. As the Work progresses, indicate final completion percentage for each activity.
- J. Recovery Schedule: When periodic update indicates the Work is [14] <Insert number> or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- K. Distribution: Distribute copies of approved schedule to Architect[, **Construction Manager,**] Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
  2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

## 1.8 STARTUP CONSTRUCTION SCHEDULE

- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within [seven] <Insert number> days of date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award].
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first [90] <Insert number> days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

## 1.9 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within [30] <Insert number> days of date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award].
1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in [10] <Insert number> percent increments within time bar.

## 1.10 CPM SCHEDULE REQUIREMENTS

- A. General: Prepare network diagrams using AON (activity-on-node) format.

- B. Startup Network Diagram: Submit diagram within [14] <Insert number> days of date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award]. Outline significant construction activities for the first [90] <Insert number> days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a [cost- and resource-loaded,] time-scaled CPM network analysis diagram for the Work.
1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than [60] <Insert number> days after date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award].
    - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.
  2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
  3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
  4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
    - a. Preparation and processing of submittals.
    - b. Mobilization and demobilization.
    - c. Purchase of materials.
    - d. Delivery.
    - e. Fabrication.
    - f. Utility interruptions.
    - g. Installation.
    - h. Work by Owner that may affect or be affected by Contractor's activities.
    - i. Testing and inspection.
    - j. Commissioning.
    - k. Punch list and final completion.
    - l. Activities occurring following final completion.
  2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
  3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.

4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
  - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, **[sustainable design documentation]**, and demonstration and training (if applicable), in the amount of **[5]** **<Insert number>** percent of the Contract Sum.
  - a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
  - b. Total cost assigned to activities shall equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
  1. Contractor or subcontractor and the Work or activity.
  2. Description of activity.
  3. Main events of activity.
  4. Immediate preceding and succeeding activities.
  5. Early and late start dates.
  6. Early and late finish dates.
  7. Activity duration in workdays.
  8. Total float or slack time.
  9. Average size of workforce.
  10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
  1. Identification of activities that have changed.
  2. Changes in early and late start dates.
  3. Changes in early and late finish dates.
  4. Changes in activity durations in workdays.
  5. Changes in the critical path.
  6. Changes in total float or slack time.
  7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.

1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
  - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
  - b. Submit value summary printouts [**one week**] <Insert time> before each regularly scheduled progress meeting.

## 1.11 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
  2. List of separate contractors at Project site.
  3. Approximate count of personnel at Project site.
  4. Equipment at Project site.
  5. Material deliveries.
  6. High and low temperatures and general weather conditions, including presence of rain or snow.
  7. Testing and inspection.
  8. Accidents.
  9. Meetings and significant decisions.
  10. Unusual events.
  11. Stoppages, delays, shortages, and losses.
  12. Meter readings and similar recordings.
  13. Emergency procedures.
  14. Orders and requests of authorities having jurisdiction.
  15. Change Orders received and implemented.
  16. [**Construction**] [**Work**] Change Directives received and implemented.
  17. Services connected and disconnected.
  18. Equipment or system tests and startups.
  19. Partial completions and occupancies.
  20. Substantial Completions authorized.
- B. Material Location Reports: At [**weekly**] [**monthly**] intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
  2. Material stored prior to previous report and since removed from storage and installed.
  3. Material stored following previous report and remaining in storage.

- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
  - 1. Submit unusual event reports directly to Owner within **[one]** <Insert number> day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

## SECTION 017300 - EXECUTION

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
1. Construction layout.
  2. Field engineering and surveying.
  3. Installation of the Work.
  4. Cutting and patching.
  5. Coordination of Owner-installed products.
  6. Progress cleaning.
  7. Starting and adjusting.
  8. Protection of installed construction.
- B. Related Requirements:
1. Section 011000 "Summary" for limits on use of Project site.
  2. Section 013300 "Submittal Procedures" for submitting surveys.
  3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
  4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
  5. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

### 1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

### 1.4 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at [**Project site**] <Insert location>.
  - 1. Prior to [**submitting cutting and patching plan**] [**commencing work requiring cutting and patching**], review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
    - a. Contractor's superintendent.
    - b. Trade supervisor responsible for cutting operations.
    - c. Trade supervisor(s) responsible for patching of each type of substrate.
    - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.
  - 2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [**land surveyor**] [**professional engineer**].
- B. Certificates: Submit certificate signed by [**land surveyor**] [**professional engineer**] certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least [**10**] <Insert number> days prior to the time cutting and patching will be performed. Include the following information:
  - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
  - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
  - 3. Products: List products to be used for patching and firms or entities that will perform patching work.
  - 4. Dates: Indicate when cutting and patching will be performed.
  - 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

- a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- E. Certified Surveys: Submit [**two**] <Insert number> copies signed by [**land surveyor**] [**professional engineer**].
- F. Final Property Survey: Submit [**10**] <Insert number> copies showing the Work performed and record survey data.

## 1.6 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
  2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. [**Operational elements include the following:**]
    - a. Primary operational systems and equipment.
    - b. Fire separation assemblies.
    - c. Air or smoke barriers.
    - d. Fire-suppression systems.
    - e. Plumbing piping systems.
    - f. Mechanical systems piping and ducts.
    - g. Control systems.
    - h. Communication systems.
    - i. Fire-detection and -alarm systems.
    - j. Conveying systems.
    - k. Electrical wiring systems.
    - l. Operating systems of special construction.
    - m. <Insert operating system>.
  3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. [**Other construction elements include but are not limited to the following:**]

- a. Water, moisture, or vapor barriers.
  - b. Membranes and flashings.
  - c. Exterior curtain-wall construction.
  - d. Sprayed fire-resistive material.
  - e. Equipment supports.
  - f. Piping, ductwork, vessels, and equipment.
  - g. Noise- and vibration-control elements and systems.
  - h. <Insert miscellaneous element>.
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, [**mechanical and electrical systems,**] and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
  - 1. Description of the Work.
  - 2. List of detrimental conditions, including substrates.
  - 3. List of unacceptable installation tolerances.
  - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to **[local utility]** **[Owner]** that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect **[ and Construction Manager]** promptly.

- B. General: Engage a [**land surveyor**] [**professional engineer**] to lay out the Work using accepted surveying practices.
1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  2. Establish limits on use of Project site.
  3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  4. Inform installers of lines and levels to which they must comply.
  5. Check the location, level and plumb, of every major element as the Work progresses.
  6. Notify Architect[ **and Construction Manager**] when deviations from required lines and levels exceed allowable tolerances.
  7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect[ **and Construction Manager**].

### 3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect[ **or Construction Manager**]. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect[ **and Construction Manager**] before proceeding.
  2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of [**two**] <Insert number> permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a **[land surveyor]** **[professional engineer]** to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by **[land surveyor]** **[professional engineer]**, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
  2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

### 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
  2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  4. Maintain minimum headroom clearance of **[96 inches (2440 mm)]** <Insert dimension> in occupied spaces and **[90 inches (2300 mm)]** <Insert dimension> in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to

confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
  - 1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

### 3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to **[minimize]** **[prevent]** interruption to occupied areas.

- G. **Cutting:** Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. **Finished Surfaces:** Cut or drill from the exposed or finished side into concealed surfaces.
  3. **[Concrete] [and] [Masonry]:** Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. **Excavating and Backfilling:** Comply with requirements in applicable Sections where required by cutting and patching operations.
  5. **Mechanical and Electrical Services:** Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- H. **Patching:** Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. **Inspection:** Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. **Exposed Finishes:** Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. **Floors and Walls:** Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
  4. **Ceilings:** Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  5. **Exterior Building Enclosure:** Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. **Cleaning:** Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 3.7 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
  - 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
  - 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

### 3.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
  - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
  - 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  - 1. Remove liquid spills promptly.
  - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in [**Section 015000 "Temporary Facilities and Controls."**] [**Section 017419 "Construction Waste Management and Disposal."**]
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.9 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

### 3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

## SECTION 017700 - CLOSEOUT PROCEDURES

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.
  - 5. Repair of the Work.
- B. Related Requirements:
  - 1. Section 013233 "Photographic Documentation" for submitting final completion construction photographic documentation.
  - 2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
  - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  - 4. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at final completion.

### 1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

### 1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of **[10]** **<Insert number>** days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
  - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by **[Architect]** **[Construction Manager]**. Label with manufacturer's name and model number.
    - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain **[Architect's]** **[Construction Manager's]** **[Owner's]** signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.
  6. Submit sustainable design submittals not previously submitted.
  7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of [10] <Insert number> days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
  2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  3. Complete startup and testing of systems and equipment.
  4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
  6. Advise Owner of changeover in utility services.
  7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  9. Complete final cleaning requirements.
  10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of [10] <Insert number> days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect[ and Construction Manager] will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
  2. Results of completed inspection will form the basis of requirements for final completion.

## 1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
  2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  4. Submit pest-control final inspection report.
  5. Submit final completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect[ **and Construction Manager**] will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

## 1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, [**starting with exterior areas first**] [**and proceeding from lowest floor to highest floor**].
  2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
  3. Include the following information at the top of each page:
    - a. Project name.
    - b. Date.
    - c. Name of Architect[ **and Construction Manager**].
    - d. Name of Contractor.
    - e. Page number.
  4. Submit list of incomplete items in the following format:
    - a. MS Excel electronic file. Architect[, **through Construction Manager,**] will return annotated file.
    - b. PDF electronic file. Architect[, **through Construction Manager,**] will return annotated file.
    - c. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).
    - d. [**Three**] **<Insert number>** paper copies. Architect[, **through Construction Manager,**] will return [**two**] **<Insert number>** copies.

## 1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial

Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

- B. Partial Occupancy: Submit properly executed warranties within **[15]** <Insert number> days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
  - 1. Submit **[on digital media acceptable to Architect]** **[by uploading to web-based project software site]** **[by email to Architect]**.
- E. Warranties in Paper Form:
  - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive **8-1/2-by-11-inch (215-by-280-mm)** paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
  - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## PART 3 - EXECUTION

## 3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean in unoccupied spaces.
    - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
    - k. Remove labels that are not permanent.
    - l. Wipe surfaces of mechanical and electrical equipment[, **elevator equipment,**] and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
    - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
    - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
    - o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.

- 1) Clean HVAC system in compliance with [NADCA ACR.] [Section 230130.52 "Existing HVAC Air-Distribution System Cleaning."] Provide written report on completion of cleaning.
    - p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
    - q. Leave Project clean and ready for occupancy.
  - C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
  - D. Construction Waste Disposal: Comply with waste disposal requirements in [Section 015000 "Temporary Facilities and Controls."] [Section 017419 "Construction Waste Management and Disposal."]
- 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
  3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

## SECTION 024116 - STRUCTURE DEMOLITION

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of buildings[ **and site improvements**].
  - 2. [**Abandoning in-place**] [**Removing**] below-grade construction.
  - 3. Disconnecting, capping or sealing, and [**abandoning in-place**] [**removing**] site utilities.
  - 4. Salvaging items for reuse by Owner.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for use of the premises and phasing requirements.
  - 2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
  - 3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
  - 4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

## 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.

- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and **[deliver to Owner ready for reuse]** **[store]**. Include fasteners or brackets needed for reattachment elsewhere.

#### 1.4 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 Owner that may be uncovered during demolition remain the property of Owner.
  - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### 1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at **[Project site]** **<Insert location>**.
  - 1. Inspect and discuss condition of construction to be demolished.
  - 2. Review structural load limitations of existing structures.
  - 3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review and finalize protection requirements.
  - 5. Review procedures for **[noise control]** **[and]** **[dust control]**.
  - 6. Review procedures for protection of adjacent buildings.
  - 7. Review items to be salvaged and returned to Owner.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, **[for environmental protection]** **[, for dust control]** **[and]** **[, for noise control]**. Indicate proposed locations and construction of barriers.
  - 1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain **[including means of egress from those buildings]**.
- D. Schedule of Building Demolition Activities: Indicate the following:
  - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
  - 2. Temporary interruption of utility services.
  - 3. Shutoff and capping **[or re-routing]** of utility services.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by

salvage and demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before the Work begins.

- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

## 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

## 1.8 QUALITY ASSURANCE

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

## 1.9 FIELD CONDITIONS

- A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
- B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
  - 1. Provide not less than [72] <Insert number> hours' notice of activities that will affect operations of adjacent occupied buildings.
  - 2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
    - a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
- C. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
  - 1. Before building demolition, Owner will remove the following items:
    - a. <Insert items to be removed by Owner>.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.
  - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

- E. Hazardous Materials: Present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
  - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  - 3. Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
- F. On-site storage or sale of removed items or materials is not permitted.

#### 1.10 COORDINATION

- A. Arrange demolition schedule so as not to interfere with [**Owner's on-site operations**] [**or**] [**operations of adjacent occupied buildings**].

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

#### 2.2 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

### PART 3 - EXECUTION

#### 3.1 DEMOLITION CONTRACTOR

- A. Demolition Contractor:
  - 1. **<Insert, in separate subparagraphs, name of Contractor prequalified to perform the Work of this Section>.**

#### 3.2 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.

- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. **[Perform] [Engage a professional engineer to 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 building demolition operations.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- F. Inventory and record the condition of items to be removed and salvaged.

### 3.3 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Salvaged Items: Comply with the following:
  - 1. Clean salvaged items of dirt and demolition debris.
  - 2. Pack or crate items after cleaning. Identify contents of containers.
  - 3. Store items in a secure area until delivery to Owner.
  - 4. Transport items to storage area **[designated by Owner] [indicated on Drawings]**.
  - 5. Protect items from damage during transport and storage.

### 3.4 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Utilities to be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.
  - 1. Owner will arrange to shut off utilities when requested by Contractor.
  - 2. Arrange to shut off utilities with utility companies.
  - 3. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
  - 4. Cut off pipe or conduit a minimum of **[24 inches (610 mm)]** <Insert depth> below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
  - 5. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

### 3.5 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

- B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of demolition.
- C. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations.
  - 1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
  - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
    - a. Provide at least [72] <Insert number> hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
- D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."
  - 1. Protect adjacent buildings and facilities from damage due to demolition activities.
  - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
  - 3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
  - 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
  - 6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
  - 7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- E. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

### 3.6 DEMOLITION, GENERAL

- A. General: Demolish indicated buildings[ **and site improvements**] completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
  - 2. Maintain fire watch during and for at least <Insert number> hours after flame-cutting operations.
  - 3. Maintain adequate ventilation when using cutting torches.
  - 4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

- B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
  - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Explosives: Use of explosives is not permitted.

### 3.7 DEMOLITION BY EXPLOSIVES

- A. Explosives: Perform explosive demolition according to governing regulations.
  - 1. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
  - 2. Do not damage adjacent structures, property, or site improvements when using explosives.
- B. Comply with recommendation in specialty explosives consultant's report.

### 3.8 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- C. Salvage: Items to be removed and salvaged are indicated [**on Drawings.**] [**below:**]
  - 1. Doors and door hardware.
  - 2. Windows.
  - 3. Cabinets.
  - 4. Mirrors.
  - 5. Chalkboards.
  - 6. Tackboards.
  - 7. Marker boards.
  - 8. Plumbing fixtures.
  - 9. **<Insert items to be salvaged>**.

- D. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.
- E. Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending [**5 feet (1.5 m)**] <Insert dimension> outside footprint indicated for new construction. Abandon below-grade construction outside this area.
  - 1. Remove below-grade construction, including basements, foundation walls, and footings, [**completely**] [**to at least 6 inches (150 mm) below grade**] [**to at least 12 inches (300 mm) below grade**] [**to depths indicated**].
- F. Below-Grade Construction: Demolish foundation walls and other below-grade construction.
  - 1. Remove below-grade construction, including basements, foundation walls, and footings, [**completely**] [**to at least 6 inches (150 mm) below grade**] [**to at least 12 inches (300 mm) below grade**] [**to depths indicated**].
- G. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
- H. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within [**5 feet (1.5 m)**] <Insert dimension> outside footprint indicated for new construction. Abandon utilities outside this area.
  - 1. Fill abandoned utility structures with [**satisfactory soil materials**] [**recycled pulverized concrete**] according to backfill requirements in Section 312000 "Earth Moving."
- I. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
- J. Hydraulic Elevator Systems: Demolish and remove elevator system, including cylinder, plunger, well assembly, steel well casing and liner, oil supply lines, and tanks.

### 3.9 SITE RESTORATION

- A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
- B. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with [**satisfactory soil materials**] [**recycled pulverized concrete**] [**recycled pulverized masonry**] according to backfill requirements in Section 312000 "Earth Moving."
- C. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

### 3.10 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.

### 3.11 DISPOSAL OF DEMOLISHED MATERIALS

- 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.] [and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."]**
  - 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.
- B. Do not burn demolished materials.

### 3.12 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
  - 1. Clean roadways of debris caused by debris transport.

END OF SECTION 024116

## SECTION 024119 - SELECTIVE DEMOLITION

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

## A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

## B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" for cutting and patching procedures.
4. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

## 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and **[deliver to Owner ready for reuse] [store]**.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

#### 1.4 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 Owner that may be uncovered during demolition remain the property of Owner.
  - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### 1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at **[Project site] <Insert location>**.
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review structural load limitations of existing structure.
  - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
  - 5. Review areas where existing construction is to remain and requires protection.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, **[for environmental protection] [, for dust control] [and] [, for noise control]**. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's [**building manager's**] [**and**] [**other tenants'**] on-site operations are uninterrupted.
  2. Interruption of utility services. Indicate how long utility services will be interrupted.
  3. Coordination for shutoff, capping, and continuation of utility services.
  4. Use of elevator and stairs.
  5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

#### 1.8 QUALITY ASSURANCE

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

#### 1.9 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
1. Before selective demolition, Owner will remove the following items:
    - a. **<Insert items to be removed by Owner>**.
- C. Notify Architect 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 Owner before start of the Work.
  2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by [**12 inches (300 mm)**] <Insert dimension> or more.
- G. Storage or sale of removed items or materials on-site is not permitted.
- H. 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.

#### 1.10 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. Notify warrantor before proceeding. Existing warranties include the following:
1. <Insert warranted system>.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

#### 1.11 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## PART 2 - PRODUCTS

### 2.1 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 ASSE A10.6 and NFPA 241.
- C. [<Double click to insert sustainable design text for building reuse.>](#)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. **[Perform]** **[Engage a professional engineer to 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.
  - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of **[measured drawings]** **[preconstruction photographs or video]** **[and]** **[templates]**.
  - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
  - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
  - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

### 3.3 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. Owner 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 Owner.
    - 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.

### 3.4 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.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

4. Cover and protect furniture, furnishings, and equipment that have not been removed.
  5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.5 SELECTIVE DEMOLITION, GENERAL

- 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. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  2. 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.
  3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. 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.
  5. Maintain fire watch during and for at least <Insert number> hours after flame-cutting operations.
  6. Maintain adequate ventilation when using cutting torches.
  7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  10. Dispose of demolished items and materials promptly. [**Comply with requirements in Section 017419 "Construction Waste Management and Disposal."**]
- 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. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms

"demolish" or "remove" shall mean historic "removal" or "dismantling" as specified in Section 024296 "Historic Removal and Dismantling."

D. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area [**on-site**] [**off-site**] [**designated by Owner**] [**indicated on Drawings**].
5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition [**and cleaned**] and reinstalled in their original locations after selective demolition operations are complete.

### 3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least **3/4 inch (19 mm)** at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." [**Do not use methods requiring solvent-based adhesive strippers.**]
- F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section **<Insert Section number and title>** for new roofing requirements.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

### 3.7 DISPOSAL OF DEMOLISHED MATERIALS

- 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.**] [**and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."**]
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 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

### 3.8 CLEANING

- A. 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.

### 3.9 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: **<Insert description of items and construction to remove>**.
- B. Remove and Salvage: **<Insert description of items to remove and salvage>**.
- C. Remove and Reinstall: **<Insert description of items to remove and reinstall>**.
- D. Existing to Remain: **<Insert description of items to remain>**.
- E. Dismantle: **<Insert description of items to be removed>**.

END OF SECTION 024119

## SECTION 033000 - CAST-IN-PLACE CONCRETE

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

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**Access Manufacturer-Provided, AIA MasterSpec-Based Sections:**

[<Double click here for this Section based on specific manufacturer's products set as Basis-of-Design at ProductMasterSpec.com.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

## A. Section Includes:

- 1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

## B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
- 2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
- 3. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
- 4. Section 033543 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
- 5. Section 035300 "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.
- 6. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
- 7. Section 321313 "Concrete Paving" for concrete pavement and walks.

8. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.
  1. Require representatives of each entity directly concerned with cast-in-place concrete 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 Subcontractor.
    - e. Special concrete finish Subcontractor.
  2. Review the following:
    - a. Special inspection and testing and inspecting agency procedures for field quality control.
    - b. Construction joints, control joints, isolation joints, and joint-filler strips.
    - c. Semirigid joint fillers.
    - d. Vapor-retarder installation.
    - e. Anchor rod and anchorage device installation tolerances.
    - f. Cold and hot weather concreting procedures.
    - g. Concrete finishes and finishing.
    - h. Curing procedures.
    - i. Forms and form-removal limitations.
    - j. Shoring and reshoring procedures.
    - k. Methods for achieving specified floor and slab flatness and levelness.
    - l. Floor and slab flatness and levelness measurements.
    - m. Concrete repair procedures.
    - n. Concrete protection.
    - o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
    - p. Protection of field cured field test cylinders.

### 1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:
  - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
9. Color pigments.
10. Fiber reinforcement.
11. Vapor retarders.
12. Floor and slab treatments.
13. Liquid floor treatments.
14. Curing materials.
  - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
15. Joint fillers.
16. Repair materials.

B. Sustainable Design Submittals:

1. [<Double click to insert sustainable design text for recycled content.>](#)
2. [<Double click to insert sustainable design text for regional materials.>](#)
3. [<Double click to insert sustainable design text for liquid floor treatments and curing and sealing compounds.>](#)

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Steel-fiber reinforcement content.
10. Synthetic micro-fiber content.
11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.

13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
14. Intended placement method.
15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - a. Location of construction joints is subject to approval of the Architect.

E. Samples: For **[manufacturer's standard colors for color pigment] [vapor retarder] <Insert products>**.

F. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
  2. Fly ash.
  3. Slag cement.
  4. Blended hydraulic cement.
  5. Silica fume.
  6. Performance-based hydraulic cement.
  7. Aggregates.
  8. Admixtures:
    - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.
- D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.
- E. Research Reports:
1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
  2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.
- F. Preconstruction Test Reports: For each mix design.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician [**with experience installing and finishing concrete, incorporating permeability-reducing admixtures**].
1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. Ready-Mixed 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 in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency

laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

- D. Field Quality Control Testing Agency Qualifications: An independent agency, [ **acceptable to authorities having jurisdiction,** ] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.
- E. Mockups: Cast concrete [ **slab-on-ground** ] [ **and** ] [ **formed-surface** ] panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
1. Slab-On-Ground: Build panel approximately **15 feet by 15 feet (3.35 meters by 3.35 meters)** <Insert area> in the location indicated or, if not indicated, as directed by Architect.
    - a. Divide panel into four equal panels to demonstrate saw joint cutting.
  2. Formed Surfaces: Build panel approximately **100 sq. ft. (9.3 sq. m)** <Insert area> in the location indicated or, if not indicated, as directed by Architect.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
1. Include the following information in each test report:
    - a. Admixture dosage rates.
    - b. Slump.
    - c. Air content.
    - d. Seven-day compressive strength.
    - e. 28-day compressive strength.
    - f. Permeability.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

## 1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with **ACI 301 (ACI 301M)** and ACI 306.1 and as follows.
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

2. When average high and low temperature is expected to fall below **40 deg F (4.4 deg C)** for three successive days, maintain delivered concrete mixture temperature within the temperature range required by **ACI 301 (ACI 301M)**.
  3. Do not use frozen materials or materials containing ice or snow.
  4. Do not place concrete in contact with surfaces less than **35 deg F (1.7 deg C)**, other than reinforcing steel.
  5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)**, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed **95 deg F (35 deg C)**.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. **ACI 301 (ACI 301M)**.

### 2.2 CONCRETE MATERIALS

- A. [<Double click to insert sustainable design text for regional materials \(concrete\).>](#)
- B. Source Limitations:
1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
  2. Obtain aggregate from single source.
  3. Obtain each type of admixture from single source from single manufacturer.
- C. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**], [**gray**] [**white**].
  2. Fly Ash: ASTM C618, Class C or F.
  3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
  4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type IL, portland-limestone**] [**Type IT, ternary blended**] cement.
  5. Silica Fume: ASTM C1240 amorphous silica.
  6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [**Type GU, general use**] [**Type HE, high early strength**] [**Type MS, moderate sulfate resistance**] [**Type HS, high sulfate resistance**] [**Type MH, moderate heat of hydration**] [**Type LH, low heat of hydration**].
- D. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 3S**] [**Class 3M**] [**Class 1N**] <Insert class> coarse aggregate or better, graded. Provide aggregates from a single source.
1. Alkali-Silica Reaction: Comply with one of the following:
    - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
    - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
    - c. Alkali Content in Concrete: Not more than **4 lb./cu. yd. (2.37 kg/cu. m)** for moderately reactive aggregate or **3 lb./cu. yd. (1.78 kg/cu. m)** for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with **ACI 301 (ACI 301M)**.
  2. Maximum Coarse-Aggregate Size: [**1-1/2 inches (38 mm)**] [**1 inch (25 mm)**] [**3/4 inch (19 mm)**] <Insert dimension> nominal.
  3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- E. Lightweight Aggregate: ASTM C330/C330M, [**1-inch (25-mm)**] [**3/4-inch (19-mm)**] [**1/2-inch (13-mm)**] [**3/8-inch (10-mm)**] nominal maximum aggregate size.
- F. Air-Entraining Admixture: ASTM C260/C260M.
- G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride [**in steel-reinforced concrete**].
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.
  7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier

and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

- a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
    - a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  9. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
    - a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
    - b. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of **200 psi (1.28 MPa)** for 14 days.
- H. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable, [**free of carbon black,**] nonfading, and resistant to lime and other alkalis.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
- I. Water and Water Used to Make Ice: ASTM C94/C94M, potable [or] [**complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4**]
- 2.3 FIBER REINFORCEMENT
- A. Carbon-Steel-Wire Fiber: ASTM A820/A820M, Type 1, cold-drawn wire, deformed, minimum of [**1.5 inches (38 mm)**] [**2 inches (50 mm)**] [**2.4 inches (60 mm)**] **<Insert dimension>** long, with an aspect ratio of [**35 to 40**] [**45 to 50**] [**60 to 65**] **<Insert ratio>**.
    1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  - B. Carbon-Steel Cut Sheet Fiber: ASTM A820/A820M, Type 2, cut sheet, deformed, minimum of [**1.5 inches (38 mm)**] [**2 inches (50 mm)**] [**2.4 inches (60 mm)**] **<Insert dimension>** long, and aspect ratio of [**35 to 40**] [**45 to 50**] [**60 to 65**] **<Insert ratio>**.
    1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- C. Synthetic Monofilament Micro-Fiber: Monofilament polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**] [**1 to 2-1/4 inches (25 to 57 mm)**] <Insert dimensions> long.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- D. Synthetic Fibrillated Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**] [**1 to 2-1/4 inches (25 to 57 mm)**] <Insert dimensions> long.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- E. Synthetic Macro-Fiber: Synthetic macro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [**1 to 2-1/4 inches (25 to 57 mm)**] <Insert dimensions> long.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.4 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A[, **except with maximum water-vapor permeance of**] <Insert rating>; not less than **10 mils (0.25 mm)** thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Sheet Vapor Retarder, Class C: ASTM E1745, Class C[, **except with maximum water-vapor permeance of**] <Insert rating>; not less than **10 mils (0.25 mm)** thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- C. Sheet Vapor Retarder/Termite Barrier: ASTM E1745, Class A, except with maximum water-vapor permeance of 0.03 perms; complying with ICC AC380. Include manufacturer's recommended adhesive or pressure-sensitive tape.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Low-Temperature Flexibility: Pass at **minus 15 deg F (minus 26 deg C)**; ASTM D146/D146M.
  3. Puncture Resistance: **224lbf (996 N)** minimum; ASTM E154/E154M.
  4. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at **70 deg F (21 deg C)**; ASTM D570.
  5. Hydrostatic-Head Resistance: **231 feet (70 m)** minimum; ASTM D5385.
- D. Bituminous Vapor Retarder: ASTM E1993/E1993M, **110-mil- (2.8-mm-)** thick, semiflexible, seven-ply sheet membrane, consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weather coating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2. Water-Vapor Permeance: **0.0011 grains/h x sq. ft. x inches Hg** (0.063 ng/Pa x s x sq. m) when tested in accordance with ASTM E154/E154M.
3. Tensile Strength: **156 lbf/inch** (27.35 kN/m) when tested in accordance with ASTM E154/E154M.
4. Puncture Resistance: **140 lbf** (662N) when tested in accordance with ASTM E154/E154M.

## 2.5 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, 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 with 100 percent passing [**3/8-inch (10-mm)**] [**No. 4 (4.75-mm)**] [**No. 8 (2.36-mm)**] <Insert size or gradation> sieve.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- C. Emery Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
  1. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
- D. Metallic Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.
  1. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].
- E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- F. Pigmented Mineral Dry-Shake Floor 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. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**].

## 2.6 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. [<Double click to insert sustainable design text for floor treatment products.>](#)

## 2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
1. Color:
    - a. Ambient Temperature Below **50 deg F (10 deg C)**: Black.
    - b. Ambient Temperature between **50 deg F (10 deg C)** and **85 deg F (29 deg C)**: Any color.
    - c. Ambient Temperature Above **85 deg F (29 deg C)**: White.
- D. Curing Paper: **Eight-foot- (2438-mm-)** wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B[, **certified by curing compound manufacturer to not interfere with bonding of floor covering**].
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating[, **certified by curing compound manufacturer to not interfere with bonding of floor covering**].
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. [<Double click to insert sustainable design text for floor treatment products.>](#)
- J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. [<Double click to insert sustainable design text for floor treatment products.>](#)

## 2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: [ASTM D1751, **asphalt-saturated cellulosic fiber**] [or] [ASTM D1752, **cork or self-expanding cork**].
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [epoxy resin with a **Type A shore durometer hardness of 80**] [aromatic polyurea with a **Type A shore durometer hardness range of 90 to 95**] in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  1. [Types I and II, **nonload bearing**] [Types IV and V, **load bearing**], for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Floor Slab Protective Covering: **Eight-foot-** (2438-mm-) wide cellulose fabric.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.9 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch (3 mm)** and that can be feathered at edges to match adjacent floor elevations.
  1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)** or coarse sand, as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than [**4100 psi (29 MPa)**] **<Insert strength>** at 28 days when tested in accordance with ASTM C109/C109M.

- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3.2 to 6 mm)** or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than **[5000 psi (34.5 MPa)]** <Insert strength> at 28 days when tested in accordance with ASTM C109/C109M.

## 2.10 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301 (ACI 301M)**.
1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash or Other Pozzolans: 25 percent by mass.
  2. Slag Cement: 50 percent by mass.
  3. Silica Fume: 10 percent by mass.
  4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
  5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
1. Use **[water-reducing] [high-range water-reducing] [or] [plasticizing]** 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.
  3. Use water-reducing admixture in **[pumped concrete,] [concrete for heavy-use industrial slabs] [concrete for parking structure slabs,] [and] [concrete with a w/cm below 0.50]**.
  4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
  5. Use permeability-reducing admixture in concrete mixtures where indicated.
- D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.11 CONCRETE MIXTURES

## A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: **ACI 318 (ACI 318M)** [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**] [**4500 psi (31 MPa)**] [**4000 psi (27.6 MPa)**] [**3500 psi (24.1 MPa)**] [**3000 psi (20.7 MPa)**] [As indicated] <Insert strength> at 28 days.
3. Maximum w/cm: [**0.50**] [**0.45**] [**0.40**] <Insert number>.
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**] [**5 inches (125 mm), plus or minus 1 inch (25 mm)**] [**8 inches (200 mm), plus or minus 1 inch (25 mm)**] for concrete with verified slump of **2 to 4 inches (50 to 100 mm)** before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**] [**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**] <Insert limits>.
6. Air Content:
  - a. Exposure Class F1: [**5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**] [**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**] [**4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
  - b. Exposure Classes F2 and F3: [**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size**] [**6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size**] [**5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size**].
7. Limit water-soluble, chloride-ion content in hardened concrete to [**1.00**] [**0.30**] [**0.15**] <Insert number> percent by weight of cement.

## B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: **ACI 318 (ACI 318M)** [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
2. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**] [**4500 psi (31 MPa)**] [**4000 psi (27.6 MPa)**] [**3500 psi (24.1 MPa)**] [**3000 psi (20.7 MPa)**] [As indicated] <Insert strength> at 28 days.
3. Maximum w/cm: [**0.50**] [**0.45**] [**0.40**] <Insert number>.
4. Slump Limit: [**4 inches (100 mm), plus or minus 1 inch (25 mm)**] [**5 inches (125 mm), plus or minus 1 inch (25 mm)**] [**8 inches (200 mm), plus or minus 1 inch (25 mm)**] for concrete with verified slump of **2 to 4 inches (50 to 100 mm)** before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
5. Slump Flow Limit: [**22 inches (550 mm), plus or minus 1.5 inches (40 mm)**] [**30 inches (762 mm), plus or minus 2.5 inches (65 mm)**] <Insert limits>.
6. Air Content:

- a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
  - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
- C. Class C: Normal-weight concrete used for interior slabs-on-ground.
1. Exposure Class: ACI 318 (ACI 318M) [F0] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
  2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] [As indicated] <Insert strength> at 28 days.
  3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
  4. Minimum Cementitious Materials Content: [470 lb/cu. yd. (279 kg/cu. m)] [520 lb/cu. yd. (309 kg/cu. m)] [540 lb/cu. yd. (320 kg/cu. m)] [610 lb/cu. yd. (362 kg/cu. m)].
  5. Slump Limit: [4 inches (100 mm), plus or minus 1 inch (25 mm)] [5 inches (125 mm), plus or minus 1 inch (25 mm)] [8 inches (200 mm), plus or minus 1 inch (25 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
  6. Slump Flow Limit: [22 inches (550 mm), plus or minus 1.5 inches (40 mm)] [30 inches (762 mm), plus or minus 2.5 inches (65 mm)] <Insert limits>.
  7. Air Content:
    - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
  8. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
  9. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd. (29.7 kg/cu. m)] <Insert weight>.
  10. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert dosage>.
  11. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd. (2.4 kg/cu. m)] [5 lb/cu. yd. (3 kg/cu. m)] <Insert dosage>.
- D. Class D: Normal-weight concrete used for interior suspended slabs.

1. Exposure Class: **ACI 318 (ACI 318M)** [F0] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
  2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
  3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
  4. Minimum Cementitious Materials Content: [470 lb/cu. yd. (279 kg/cu. m)] [520 lb/cu. yd. (309 kg/cu. m)] [540 lb/cu. yd. (320 kg/cu. m)] [610 lb/cu. yd. (362 kg/cu. m)].
  5. Slump Limit: [4 inches (100 mm), plus or minus 1 inch (25 mm)] [5 inches (125 mm), plus or minus 1 inch (25 mm)] [8 inches (200 mm), plus or minus 1 inch (25 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
  6. Slump Flow Limit: [22 inches (550 mm), plus or minus 1.5 inches (40 mm)] [30 inches (762 mm), plus or minus 2.5 inches (65 mm)] <Insert limits>.
  7. Air Content:
    - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
  8. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
  9. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd. (29.7 kg/cu. m)] <Insert weight>.
  10. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert dosage>.
  11. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd. (2.4 kg/cu. m)] [5 lb/cu. yd. (3 kg/cu. m)] <Insert dosage>.
- E. Class E: Structural lightweight concrete used for interior suspended slabs.
1. Exposure Class: **ACI 318 (ACI 318M)** [F0] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
  2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
  3. Calculated Equilibrium Unit Weight: [115 lb/cu. ft. (1842 kg/cu. m)] [110 lb/cu. ft. (1762 kg/cu. m)] [105 lb/cu. ft. (1682 kg/cu. m)], plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C567/C567M.
  4. Slump Limit: [4 inches (100 mm), plus or minus 1 inch (25 mm)] [5 inches (125 mm), plus or minus 1 inch (25 mm)] [8 inches (200 mm), plus or minus 1 inch (25 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
  5. Slump Flow Limit: [22 inches (550 mm), plus or minus 1.5 inches (40 mm)] [30 inches (762 mm), plus or minus 2.5 inches (65 mm)] <Insert limits>.
  6. Air Content:

- a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
  8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd. (29.7 kg/cu. m)] <Insert weight>.
  9. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert dosage>.
  10. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd. (2.4 kg/cu. m)] [5 lb/cu. yd. (3 kg/cu. m)] <Insert dosage>.
- F. Class F: Normal-weight concrete used for concrete toppings.
1. Exposure Class: ACI 318 (ACI 318M) [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
  2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
  3. Minimum Cementitious Materials Content: [470 lb/cu. yd. (279 kg/cu. m)] [520 lb/cu. yd. (309 kg/cu. m)] [540 lb/cu. yd. (320 kg/cu. m)].
  4. Slump Limit: [4 inches (100 mm)] [5 inches (125 mm)], plus or minus 1 inch (25 mm).
  5. Air Content:
    - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
    - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
  6. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
    - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished toppings.
  7. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd. (29.7 kg/cu. m)] <Insert weight>.
  8. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert dosage>.

9. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd. (2.4 kg/cu. m)] [5 lb/cu. yd. (3 kg/cu. m)] <Insert dosage>.

G. Class G: Normal-weight concrete used for building frame members.

1. Exposure Class: ACI 318 (ACI 318M) [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
4. Slump Limit: [4 inches (100 mm), plus or minus 1 inch (25 mm)] [5 inches (125 mm), plus or minus 1 inch (25 mm)] [8 inches (200 mm), plus or minus 1 inch (25 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
5. Slump Flow Limit: [22 inches (550 mm), plus or minus 1.5 inches (40 mm)] [30 inches (762 mm), plus or minus 2.5 inches (65 mm)] <Insert limits>.
6. Air Content:
  - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
  - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.

H. Class H: Normal-weight concrete used for building walls.

1. Exposure Class: ACI 318 (ACI 318M) [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
4. Slump Limit: [4 inches (100 mm), plus or minus 1 inch (25 mm)] [5 inches (125 mm), plus or minus 1 inch (25 mm)] [8 inches (200 mm), plus or minus 1 inch (25 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.

5. Slump Flow Limit: [22 inches (550 mm), plus or minus 1.5 inches (40 mm)] [30 inches (762 mm), plus or minus 2.5 inches (65 mm)] <Insert limits>.
  6. Air Content:
    - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
    - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].
  7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
- I. Class I: Normal-weight concrete used for interior metal pan stairs and landings:
1. Exposure Class: ACI 318 (ACI 318M) [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
  2. Minimum Compressive Strength: [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
  3. Maximum w/cm: [0.53] [0.45] [0.40] <Insert number>.
  4. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m).
  5. Maximum Size Aggregate: 1/2 inch (13 mm).
  6. Slump Limit: 3 inches (75 mm), plus 1 inch (25 mm) or minus 2 inches (50 mm).
  7. Air Content: [0] <Insert number> percent, plus or minus 0.5 percent at point of delivery.
  8. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
  9. Retarding Admixture: Not allowed.
  10. Accelerating Admixture: Not allowed.
- J. Class J: Normal-weight concrete used for exterior retaining walls.
1. Exposure Class: ACI 318 (ACI 318M) [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
  2. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> [As indicated] at 28 days.
  3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
  4. Slump Limit: [4 inches (100 mm), plus or minus 1 inch (25 mm)] [5 inches (125 mm), plus or minus 1 inch (25 mm)] [8 inches (200 mm), plus or minus 1 inch (25 mm)] for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
  5. Slump Flow Limit: [22 inches (550 mm), plus or minus 1.5 inches (40 mm)] [30 inches (762 mm), plus or minus 2.5 inches (65 mm)] <Insert limits>.

6. Air Content:
  - a. Exposure Class F1: **[5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].**
  - b. Exposure Classes F2 and F3: **[6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size].**
7. Limit water-soluble, chloride-ion content in hardened concrete to **[1.00] [0.30] [0.15]** **<Insert number>** percent by weight of cement.

## 2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M[ **and ASTM C1116/C1116M**], and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
  1. For mixer capacity of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 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. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
  3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions:
  1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
  2. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Secure facilities for storage, initial curing, and field curing of test samples, including continuous electrical power.
  4. Security and protection for samples and for testing and inspection equipment at Project site.

### 3.3 INSTALLATION OF 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.
1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
  3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

### 3.4 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
  2. Face laps away from exposed direction of concrete pour.
  3. Lap vapor retarder over footings and grade beams not less than **6 inches (150 mm)**, sealing vapor retarder to concrete.
  4. Lap joints **6 inches (150 mm)** and seal with manufacturer's recommended tape.
  5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
  6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
  7. Protect vapor retarder during placement of reinforcement and concrete.
    - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by **6 inches (150 mm)** on all sides, and sealing to vapor retarder.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

### 3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
  - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
  - 2. Place joints perpendicular to main reinforcement.
    - a. Continue reinforcement across construction joints unless otherwise indicated.
    - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 3. Form keyed joints as indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
  - 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - 6. Space vertical joints in walls [**as indicated on Drawings**] **<Insert spacing>**. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least [**one-fourth**] **<Insert depth>** of concrete thickness as follows:
  - 1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch (3.2 mm)**. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  - 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3.2-mm-)** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
  - 2. Terminate full-width joint-filler strips not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
  - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

- E. Doweled Joints:
  - 1. Install dowel bars and support assemblies at joints where indicated on Drawings.
  - 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
  - 1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
  - 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of **ACI 301 (ACI 301M)**, but not to exceed the amount indicated on the concrete delivery ticket.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
  - 1. If a section cannot be placed continuously, provide construction joints as indicated.
  - 2. Deposit concrete to avoid segregation.
  - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with **ACI 301 (ACI 301M)**.
    - a. Do not use vibrators to transport concrete inside forms.
    - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches (150 mm)** into preceding layer.
    - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.

- d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
  2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  3. Maintain reinforcement in position on chairs during concrete placement.
  4. Screed slab surfaces with a straightedge and strike off to correct elevations.
  5. Level concrete, cut high areas, and fill low areas.
  6. Slope surfaces uniformly to drains where required.
  7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
  8. Do not further disturb slab surfaces before starting finishing operations.

### 3.7 FINISHING FORMED SURFACES

#### A. As-Cast Surface Finishes:

1. **ACI 301 (ACI 301M)** Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
  - a. Patch voids larger than **1-1/2 inches (38 mm)** wide or **1/2 inch (13 mm)** deep.
  - b. Remove projections larger than **1 inch (25 mm)**.
  - c. Tie holes do not require patching.
  - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class D.
  - e. Apply to concrete surfaces [**not exposed to public view**] **<Insert locations>**.
2. **ACI 301 (ACI 301M)** Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
  - a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
  - b. Remove projections larger than **1/4 inch (6 mm)**.
  - c. Patch tie holes.
  - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class B.
  - e. Locations: Apply to concrete surfaces [**exposed to public view,**] [**to receive a rubbed finish,**] [**or to be covered with a coating or covering material applied directly to concrete**] **<Insert locations>**.
3. **ACI 301 (ACI 301M)** Surface Finish SF-3.0:
  - a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
  - b. Remove projections larger than **1/8 inch (3 mm)**.
  - c. Patch tie holes.
  - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class A.

- e. Locations: Apply to concrete surfaces [**exposed to public view,**] [**to receive a rubbed finish,**] [**or to be covered with a coating or covering material applied directly to concrete**] <Insert locations>.
- B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:
1. Smooth-Rubbed Finish:
    - a. Perform no later than one day after form removal.
    - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
    - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
  2. Grout-Cleaned Rubbed Finish:
    - a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
    - b. Do not clean concrete surfaces as Work progresses.
    - c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
    - d. Wet concrete surfaces.
    - e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
  3. Cork-Floated Finish:
    - a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
    - b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
    - c. Wet concrete surfaces.
    - d. Compress grout into voids by grinding surface.
    - e. In a swirling motion, finish surface with a cork float.
- C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
1. Perform abrasive blasting after compressive strength of concrete exceeds **2000 psi (13.8 MPa)**.
  2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
  3. Surface Continuity:
    - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
    - b. Maintain required patterns or variances in depths of blast to match field samples.

4. Abrasive Blasting:
  - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
  - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
  - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
    - 1) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of **1/4 inch (6 mm)**.

D. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.8 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of **1/4 inch (6 mm)** in one direction.
3. Apply scratch finish to surfaces **[to receive concrete floor toppings] [to receive mortar setting beds for bonded cementitious floor finishes] <Insert locations>**.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with **ACI 117 (ACI A117M)** tolerances for conventional concrete.
3. Apply float finish to surfaces **[to receive trowel finish] [and] [to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo] <Insert locations>**.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.

2. Continue troweling passes and restraighthen until surface is free of trowel marks and uniform in texture and appearance.
  3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  4. Do not add water to concrete surface.
  5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
  6. Apply a trowel finish to surfaces [**exposed to view**] [**or**] [**to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system**] <Insert locations>.
  7. Finish surfaces to the following tolerances, in accordance with **ASTM E1155 (ASTM E1155M)**, for a randomly trafficked floor surface:
    - a. Slabs on Ground:
      - 1) Specified overall values of flatness,  $F_F$  25; and of levelness,  $F_L$  20; with minimum local values of flatness,  $F_F$  17; and of levelness,  $F_L$  15.
      - 2) 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.
      - 3) Specified overall values of flatness,  $F_F$  45; and of levelness,  $F_L$  35; with minimum local values of flatness,  $F_F$  30; and of levelness,  $F_L$  24.
      - 4) Specified Overall Value (SOV):  $F_F$  50 and  $F_L$  25 with minimum local value (MLV):  $F_F$  40 and  $F_L$  17.
      - 5) Specified Overall Value (SOV):  $F_F$  25 and  $F_L$  20 with minimum local value (MLV):  $F_F$  17 and  $F_L$  15.
    - b. Suspended Slabs:
      - 1) Specified overall values of flatness,  $F_F$  25; and of levelness,  $F_L$  20; with minimum local values of flatness,  $F_F$  17; and of levelness,  $F_L$  15.
      - 2) Specified overall values of flatness,  $F_F$  35; and of levelness,  $F_L$  20; with minimum local values of flatness,  $F_F$  24; and of levelness,  $F_L$  15.
      - 3) Specified overall values of flatness,  $F_F$  45; and of levelness,  $F_L$  35; with minimum local values of flatness,  $F_F$  30; and of levelness,  $F_L$  24.
  8. Finish and measure surface, so gap at any point between concrete surface and an unveled, freestanding, **10-ft.- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**] [**3/16 inch (4.8 mm)**] [**1/8 inch (3 mm)**].
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces [**indicated on Drawings**] [**where ceramic or quarry tile is to be installed by either thickset or thinset method**]. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
1. Coordinate required final finish with Architect before application.
  2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
  2. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive [**aggregate**] [**aluminum granule**] finish to concrete stair treads, platforms, ramps as indicated on Drawings
1. Apply in accordance with manufacturer's written instructions and as follows:
    - a. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**] <Insert rate> of dampened slip-resistive [**aggregate**] [**aluminum granules**] over surface in one or two applications.
    - b. Tamp aggregate flush with surface, but do not force below surface.
    - c. After broadcasting and tamping, apply float finish.
    - d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive [**aggregate**] [**aluminum granules**].
- H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:
1. Uniformly apply dry-shake floor hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**] <Insert rate> unless greater amount is recommended by manufacturer.
  2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
  3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
  4. After final floating, apply a trowel finish.
  5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

### 3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

#### A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

#### B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

#### C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases [**4 inches (100 mm)**] [**6 inches (150 mm)**] [**8 inches (200 mm)**] <Insert dimension> high unless otherwise indicated on Drawings, and extend base not less than **6 inches (150 mm)** in each direction beyond the maximum dimensions of

supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.

3. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert value> at 28 days.
  4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) 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 substrate.
  6. Prior to pouring concrete, place and secure anchorage devices.
    - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - b. Cast anchor-bolt insert into bases.
    - c. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
1. Cast-in inserts and accessories, as shown on Drawings.
  2. Screed, tamp, and trowel finish concrete surfaces.

### 3.10 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
1. Comply with ACI 301 (ACI 301M) and ACI 306.1 for cold weather protection during curing.
  2. Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) 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. x h (1 kg/sq. m x h) before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
  2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
  3. If forms remain during curing period, moist cure after loosening forms.
  4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
    - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    - b. Continuous Sprinkling: Maintain concrete surface continuously wet.

- c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
- d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
- e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
  - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
  - 2) Maintain continuity of coating and repair damage during curing period.

D. Curing Unformed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

- 1. Begin curing immediately after finishing concrete.
- 2. Interior Concrete Floors:
  - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
    - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      - a) Lap edges and ends of absorptive cover not less than **12-inches (300-mm)**.
      - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
    - 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 (300 mm)**, and sealed by waterproof tape or adhesive.
      - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
      - b) Cure for not less than seven days.
    - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
      - a) Water.
      - b) Continuous water-fog spray.
  - b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
    - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

- a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).
  - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
- 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 (300 mm), and sealed by waterproof tape or adhesive.
- a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
  - b) Cure for not less than seven days.
- 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
- a) Water.
  - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
    - a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).
    - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
  - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
  - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
  - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
  - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. Floors to Receive Urethane Flooring:

- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
- 2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped **6 inches (150 mm)** and sealed in place.
- 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
- 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:

- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Maintain continuity of coating, and repair damage during curing period.
- 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[ **unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project**].

g. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

### 3.11 TOLERANCES

- A. Conform to **ACI 117 (ACI 117M)**.

### 3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  2. Do not apply to concrete that is less than **[three] [seven] [14] [28]** days' old.
  3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
  4. Rinse with water; remove excess material until surface is dry.
  5. Apply a second coat in a similar manner if surface is rough or porous.

- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

### 3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
  - 1. Defer joint filling until concrete has aged at least **[one]** **[six]** month(s).
  - 2. 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 joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least **2 inches (50 mm)** deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

### 3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
  - 1. Repair and patch defective areas when approved by Architect.
  - 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a **No. 16 (1.18-mm)** sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than **1/2 inch (13 mm)** in any dimension to solid concrete.
    - a. Limit cut depth to **3/4 inch (19 mm)**.
    - b. Make edges of cuts perpendicular to concrete surface.
    - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    - d. Fill and compact with patching mortar before bonding agent has dried.
    - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
    - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    - b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
  - a. Correct low and high areas.
  - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of **0.01 inch (0.25 mm)** wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
  - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
  - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
  - a. Cut out low areas to ensure a minimum repair topping depth of **1/4 inch (6 mm)** to match adjacent floor elevations.
  - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes **1 inch (25 mm)** or less in diameter, by cutting out and replacing with fresh concrete.
  - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a **3/4-inch (19-mm)** clearance all around.
  - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
  - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
  - d. Place, compact, and finish to blend with adjacent finished concrete.
  - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes **1 inch (25 mm)** or less in diameter with patching mortar.

- a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
  - b. Dampen cleaned concrete surfaces and apply bonding agent.
  - c. Place patching mortar before bonding agent has dried.
  - d. Compact patching mortar and finish to match adjacent concrete.
  - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
1. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
  2. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
      - 1) Project name.
      - 2) Name of testing agency.
      - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
      - 4) Name of concrete manufacturer.
      - 5) Date and time of inspection, sampling, and field testing.
      - 6) Date and time of concrete placement.
      - 7) Location in Work of concrete represented by samples.
      - 8) Date and time sample was obtained.
      - 9) Truck and batch ticket numbers.
      - 10) Design compressive strength at 28 days.
      - 11) Concrete mixture designation, proportions, and materials.
      - 12) Field test results.
      - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
      - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size,

design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
  - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
  - a. 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.
  - b. Perform additional tests when concrete consistency appears to change.
3. Slump Flow: ASTM C1611/C1611M:
  - a. 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.
  - b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; **[ASTM C173/C173M volumetric method, for structural lightweight concrete]**.
  - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
  - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
  - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

7. Compression Test Specimens: ASTM C31/C31M:
    - a. Cast and laboratory cure two sets of [two] [three] [four] 6-inch (150 mm) by 12-inch (300 mm) cylinder specimens for each composite sample.
    - b. Cast, initial cure, and field cure [two] <Insert number> sets of [two] [three] [four] standard cylinder specimens for each composite sample.
  8. Compressive-Strength Tests: ASTM C39/C39M.
    - a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
    - b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
    - c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  9. 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.
  10. Strength of each concrete mixture 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 (3.4 MPa) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).
  11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
  12. Additional Tests:
    - a. 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 Architect.
    - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
      - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 (ACI 301M), section 1.6.6.3.
  13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 (ASTM E1155M) within [24] [48] [72] <Insert number> hours of completion of floor finishing and promptly report test results to Architect.

### 3.16 PROTECTION

#### A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

## SECTION 033053 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
  - 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
  - 2. Section 321313 "Concrete Paving" for concrete pavement and walks.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. [<Double click to insert sustainable design text for recycled content.>](#)
  - 2. [<Double click to insert sustainable design text for regional materials.>](#)
  - 3. [<Double click to insert sustainable design text for curing and sealing compounds.>](#)
- C. Design Mixtures: For each concrete mixture.

## 1.4 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. Comply with the following sections of **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents:
  - 1. "General Requirements."
  - 2. "Formwork and Formwork Accessories."
  - 3. "Reinforcement and Reinforcement Supports."
  - 4. "Concrete Mixtures."
  - 5. "Handling, Placing, and Constructing."
  - 6. "Lightweight Concrete."
- B. Comply with **ACI 117 (ACI 117M)**.

### 2.2 STEEL REINFORCEMENT

- A. [<Double click to insert sustainable design text for recycled content of steel products.>](#)
- B. Reinforcing Bars: ASTM A 615/A 615M, **Grade 60 (Grade 420)**, deformed.
- C. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
- D. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

### 2.3 CONCRETE MATERIALS

- A. [<Double click to insert sustainable design text for regional materials \(concrete\).>](#)
- B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- C. Cementitious Materials:
  - 1. Portland Cement: ASTM C 150/C 150M, **[Type I] [Type II] [Type I/II] [Type III] [Type V]**.
  - 2. Fly Ash: ASTM C 618, Class C or F.

3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
  4. Blended Hydraulic Cement: ASTM C 595/C 595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type IL, portland-limestone**] [**Type IT, ternary blended**] cement.
- D. Normal-Weight Aggregate: ASTM C 33/C 33M, [**1-1/2-inch (38-mm)**] <Insert dimension> nominal maximum aggregate size.
- E. Lightweight Aggregate: ASTM C 330/C 330M, [**1-inch (25-mm)**] <Insert dimension> nominal maximum aggregate size.
- F. Air-Entraining Admixture: ASTM C 260/C 260M.
- G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- H. Water: ASTM C 94/C 94M.

## 2.4 FIBER REINFORCEMENT

- A. Synthetic Micro-Fiber: [**Monofilament**] [**or**] [**fibrillated**] polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**] <Insert dimensions> long.

## 2.5 RELATED MATERIALS

- A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.
- B. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than **10 mils (0.25 mm)** thick; or plastic sheet, ASTM E 1745, Class C.
- C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

## 2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.

- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Clear, **[Waterborne]** **[Solvent-Borne]**, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
  - 1. [<Double click to insert sustainable design text for floor treatment products.>](#)

## 2.7 CONCRETE MIXTURES

- A. Comply with **ACI 301 (ACI 301M)**.
- B. Normal-Weight Concrete:
  - 1. Minimum Compressive Strength: [**4500 psi (31 MPa)**] [**4000 psi (27.6 MPa)**] [**3500 psi (24.1 MPa)**] [**3000 psi (20.7 MPa)**] [**As indicated**] **<Insert strength>** at 28 days.
  - 2. Maximum W/C Ratio: [**0.50**] [**0.45**] [**0.40**] **<Insert number>**.
  - 3. Cementitious Materials: Use fly ash, pozzolan, slag cement, and blended hydraulic cement as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
  - 4. Slump Limit: [**4 inches (100 mm)**] [**5 inches (125 mm)**] [**8 inches (200 mm)**] **for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture** **<Insert limit>**, plus or minus **1 inch (25 mm)**.
  - 5. Air Content: Maintain within range permitted by **ACI 301 (ACI 301M)**. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.
- C. Structural Lightweight Concrete Mix: ASTM C 330/C 330M, proportioned to produce concrete with a minimum compressive strength of [**3000 psi (20.7 MPa)**] **<Insert strength>** at 28 days and a calculated equilibrium unit weight of [**110 lb/cu. ft. (1762 kg/cu. m)**] **<Insert weight>** plus or minus **3 lb/cu. ft. (48.1 kg/cu. m)**, as determined by ASTM C 567/C 567M. Concrete slump at point of placement shall be the minimum necessary for efficient mixing, placing, and finishing.
  - 1. Limit slump to **5 inches (125 mm)** for troweled slabs and **4 inches (100 mm)** for other slabs.
- D. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than a rate of [**1.0 lb/cu. yd. (0.60 kg/cu. m)**] [**1.5 lb/cu. yd. (0.90 kg/cu. m)**] **<Insert dosage>**.

## 2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M [**and ASTM C 1116/C 1116**], and furnish batch ticket information.

1. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. (0.76 cu. m) 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 mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
  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

### 3.1 FORMWORK INSTALLATION

- A. Design, construct, erect, brace, and maintain formwork according to ACI 301 (ACI 301M).

### 3.2 EMBEDDED ITEM INSTALLATION

- 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.

### 3.3 VAPOR-RETARDER INSTALLATION

- A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.
1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended adhesive or joint tape.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

### 3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least [**one-fourth**] <Insert depth> of concrete thickness, as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch (3.2 mm)**. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
  - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3.2-mm-)** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

### 3.6 CONCRETE PLACEMENT

- A. Comply with **ACI 301 (ACI 301M)** for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of **ACI 301 (ACI 301M)**.
- C. Do not add water to concrete during delivery, at Project site, or during placement.
- D. Consolidate concrete with mechanical vibrating equipment according to **ACI 301 (ACI 301M)**.
- E. Equipment Bases and Foundations:
  - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  - 2. Construct concrete bases [**4 inches (100 mm)**] [**6 inches (150 mm)**] [**8 inches (200 mm)**] <Insert dimension> high unless otherwise indicated; and extend base not less than **6 inches (150 mm)** in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
  - 3. Minimum Compressive Strength: [**5000 psi (34.5 MPa)**] [**4500 psi (31 MPa)**] [**4000 psi (27.6 MPa)**] [**3500 psi (24.1 MPa)**] [**3000 psi (20.7 MPa)**] <Insert value> at 28 days.
  - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
  - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor them into structural concrete substrate.
  - 6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

### 3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding **1/2 inch (13 mm)**.
  1. Apply to concrete surfaces [**not exposed to public view**] **<Insert locations>**.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding **1/8 inch (3 mm)**.
  1. Apply to concrete surfaces [**exposed to public view,**] [**to receive a rubbed finish,**] [**or to be covered with a coating or covering material applied directly to concrete**] **<Insert locations>**.
- C. Rubbed Finish: Apply the following rubbed finish, defined in **ACI 301 (ACI 301M)**, to smooth-formed-finished as-cast concrete where indicated:
  1. Smooth-rubbed finish.
  2. Grout-cleaned finish.
  3. Cork-floated finish.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.8 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
  1. Do not further disturb surfaces before starting finishing operations.
- C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.

- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
- F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Slip-Resistive Broom Finish: Apply a slip-resistive finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

### 3.9 CONCRETE PROTECTING 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 **ACI 305.1 (ACI 305.1M)** for hot-weather protection during curing.
- B. 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 (1 kg/sq. m 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.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days 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 (300-mm)** 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 (300 mm)**, 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.
  - 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 and slabs 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.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to **ACI 301 (ACI 301M)**.
  - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding **5 cu. yd. (4 cu. m)**, but less than **25 cu. yd. (19 cu. m)**, plus one set for each additional **50 cu. yd. (38 cu. m)** or fraction thereof.
  - 2. Testing Frequency: Obtain at least one composite sample for each **100 cu. yd. (76 cu. m)** or fraction thereof of each concrete mixture placed each day.

END OF SECTION 033053

## SECTION 281300 - ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

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**Access Manufacturer-Provided, AIA MasterSpec-Based Sections:**

[<Double click here for this Section based on specific manufacturer's products set as Basis-of-Design at ProductMasterSpec.com.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

## A. Section Includes:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

## B. Related Requirements:

1. Section 281500 "Access Control System Hardware Devices" for access control system hardware, such as keypads, card readers, and biometric identity devices.

## 1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.
- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Diagrams for cable management system.
  - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
  - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
    - a. Workstation outlets, jacks, and jack assemblies.
    - b. Patch cords.
    - c. Patch panels.

4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

C. Product Schedules.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

## 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Workstation operating system documentation.
2. Workstation installation and operating documentation, manuals, and software for the workstation and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each workstation.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on [USB] [cloud] media of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

## 1.7 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. Laser Printers: Three toner cassettes and one replacement drum unit.
2. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra [50] <Insert number> percent for future use.
3. Fuses of all kinds, power and electronic, equal to [10] <Insert number> percent of amount installed for each size used, but no fewer than three units.
4. <Insert materials>.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.

- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

## 1.9 DELIVERY, STORAGE, AND HANDLING

### A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between **50 and 85 deg F (10 and 30 deg C)**, and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.10 PROJECT CONDITIONS

### A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of **60 to 85 deg F (16 to 30 deg C)** and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in **[air-conditioned] [temperature-controlled]** indoor environments shall be rated for continuous operation in ambient conditions of **[36 to 122 deg F (2 to 50 deg C)]** <Insert temperature range> dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, **[Type 3R] [Type 4] [Type 12] [Type 12K]** enclosures. System components installed in **[non-air-conditioned] [non-temperature-controlled]** indoor environments shall be rated for continuous operation in ambient conditions of **[0 to 122 deg F (minus 18 to plus 50 deg C)]** <Insert temperature range> dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250, **[Type 3] [Type 3R] [Type 3S] [Type 4] [Type 4X]** enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of **[minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)]** <Insert temperature range> dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to **85 mph (137 km/h)**[ **and snow cover up to 24 inches (610 mm) thick**].
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, **[Type 4X] [Type 6P]** enclosures.

## PART 2 - PRODUCTS

## 2.1 ACCESS CONTROL SOFTWARE

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.2 DESCRIPTION

- A. Security Access System: Workstation-based central station[, **one or more networked workstation-based workstations,**] and field-installed controllers, connected by a high-speed electronic-data transmission network.
- B. System Software: Based on [32] [64] **<Insert number>-bit, <Insert name of operating system>** central-station, workstation operating system, server operating system, and application software. Software shall have the following capabilities:
1. Multiuser and multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
  2. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of the operating system.
  3. System license for the entire system including capability for future additions that are within the indicated system size limits specified in this Section.
  4. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
  5. Password-protected operator login and access.
  6. Open-database-connectivity compliant.
- C. Network connecting the central station and workstations shall be a [LAN] [WAN] using TCP/IP with a capacity of connecting up to [99] **<insert number>** workstations. System shall be portable across multiple communication platforms without changing system software.
- D. Network(s) connecting workstations and controllers shall consist of one or more of the following:
1. Local area, IEEE 802.3 Fast Ethernet [**Gigabit-Ethernet**] [**100 BASE-TX**], star topology network based on TCP/IP.
  2. Local area, IEEE 802.11 compatible wireless mesh network, based on TCP/IP.
  3. Direct-connected, RS-232 cable from the COM port of the central station to the first controller, then RS-485 cable to interconnect the remaining controllers at that Location.

## 2.3 OPERATION

- A. Security access system shall use a single database for access-control and credential-creation functions.
- B. Distributed Processing: A fully distributed processing system.

1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
  2. Intermediate controllers for access control are prohibited.
  3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.
- C. Number of Locations:
1. Support at least **[32,000]** <Insert number> separate Locations using a single workstation with combinations of direct-connect, or TCP/IP LAN connections to each Location.
  2. Each Location shall have its own database and history in the central station.
  3. Locations may be combined to share a common database.
- D. Data Capacity:
1. **[130]** <Insert number> different card-reader formats.
  2. **[999]** <Insert number> comments.
  3. **[48]** <Insert number> graphic file types for importing maps.
- E. Location Capacity:
1. **[1024]** <Insert number> reader-controlled doors.
  2. **[50,000]** <Insert number> total-access credentials.
  3. **[2048]** <Insert number> supervised alarm inputs.
  4. **[2048]** <Insert number> programmable outputs.
  5. **[32,000]** <Insert number> custom action messages per Location to instruct operator on action required when alarm is received.
- F. System Network Requirements:
1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
  2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
  3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
  4. Communications controller may be used as an interface between the central-station display systems and the field device network. Communications controller shall provide functions required to attain the specified network communications performance.
- G. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers.
- H. Field equipment shall include controllers, sensors, and controls.
1. Controllers shall serve as an interface between the central station and sensors and controls.

2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
  3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
  4. Controllers are classified as alarm-annunciation or entry-control type.
- I. System Response to Alarms:
1. Field device network shall provide a system end-to-end response time of **[one]** <Insert number> second(s) or less for every device connected to the system.
  2. Alarms shall be annunciated at the central station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the central station.
  3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the central station.
  4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
  5. This response time shall be maintained during system heavy load.
- J. False-Alarm Reduction: The design of the central station and controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.
- K. Error Detection:
1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
  2. Interactive or product error-detection codes alone will not be acceptable.
  3. A message shall be in error if one bit is received incorrectly.
  4. Retransmit messages with detected errors.
  5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
  6. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
  7. Monitor the frequency of data transmission failure for display and logging.
- L. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.
- M. Door Hardware Interface:
1. Comply with requirements in Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for door hardware required to be monitored or controlled by the security access system.
  2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

## 2.4 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. Comply with NFPA 70, "National Electrical Code."
- C. Comply with [**SIA DC-01 and** ]SIA DC-03[ **and SIA DC-07**].

## 2.5 APPLICATION SOFTWARE

- A. System Software: Based on [32] <Insert number>-bit, [**Microsoft Windows**] <Insert operating system> central-station and workstation operating system and application software.
  - 1. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.
  - 2. Graphical user interface shall show pull-down menus and a menu-tree format.
  - 3. Capability for future additions within the indicated system size limits.
  - 4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
  - 5. Password-protected operator login and access.
- B. Peer Computer Control Software: Detect a failure of a central computer and cause the other central computer to assume control of all system functions without interruption of operation. Both central computers shall have drivers to support this mode of operation.
- C. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors[ **and DTS links**], operate displays, report alarms, generate reports, and help train system operators.
  - 1. Reside at the central station, workstations, and controllers as required to perform specified functions.
  - 2. Operate and manage peripheral devices.
  - 3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
  - 4. Import custom icons into graphics to represent alarms and I/O devices.
  - 5. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
  - 6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
  - 7. Messages from workstation to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
  - 8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other workstation-to-controller communications

methods by changing the polling frequency and the amount of time the system waits for a response.

9. Automatic and encrypted backups for database and history backups shall be automatically stored at [**the central-control workstation**] [**a selected workstation**] and encrypted with a nine-character alphanumeric password that must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.
11. Support network protocol and topology, TCP/IP, Novel Netware, Digital Pathworks, Banyan Vines, LAN/WAN, and RAS.

D. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

E. Controller Software:

1. Controllers shall operate as autonomous, intelligent processing units.
  - a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
  - b. Controllers shall be part of a fully distributed processing-control network.
  - c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.
2. The following functions shall be fully implemented and operational within each controller:
  - a. Monitoring inputs.
  - b. Controlling outputs.
  - c. Automatically reporting alarms to the central station.
  - d. Reporting of sensor and output status to the central station on request.
  - e. Maintaining real time, automatically updated by the central station at least once a day.
  - f. Communicating with the central station.
  - g. Executing controller resident programs.
  - h. Diagnosing.
  - i. Downloading and uploading data to and from the central station.
3. Controller Operations at a Location:
  - a. Up to [64] <Insert number> controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation

intervention. Linking and anti-passback shall remain fully functional within the same Location even when the central station or workstations are off-line.

- b. In the event of communication failure between the central station and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
  - c. Buffered events shall be handled in a first-in-first-out mode of operation.
4. Individual Controller Operation:
- a. Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission to the central station. Storage capacity for the latest 1024 events shall be provided at each controller.
  - b. Card-reader ports of a controller shall be custom configurable for at least [120] <Insert number> different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
  - c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
  - d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
  - e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
  - f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
  - g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
  - h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.
5. Communications Monitoring:
- a. System shall monitor and report status of TIA 485-A communications loop of each Location.
  - b. Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.
  - c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.

6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. Workstation-to-Controller Communications:

1. Central-station or workstation communications shall use the following:
  - a. Direct connection using serial ports of the workstation.
  - b. TCP/IP LAN interface cards.
  - c. Dial-up or cable modems for connections to Locations.
2. Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only," or as an ASCII output port. Serial ports shall have adjustable data transmission rates and shall be selectable under program control.
3. Use multiport communications board if more than two serial ports are needed.
  - a. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32- or 64-serial ports.
  - b. Connect the first board to an internal PCI bus adapter card.
4. Direct serial, TCP/IP, and dial-up, cable, or satellite communications shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up or voice-over IP Location.
5. TCP/IP network interface card (NIV) shall have an option to set the poll-frequency and message-response time-out settings.
6. Workstation-to-controller and controller-to-controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered, and retransmitted if not acknowledged.

G. Direct Serial or TCP/IP Workstation-to-Controller Communications:

1. Communication software on the workstation shall supervise the workstation-to-controller communications link.
2. Loss of communications to any controller shall result in an alarm at all workstations running the communication software.
3. When communications are restored, all buffered events shall automatically upload to the workstation, and any database changes shall be automatically sent to the controller.

H. Broadband Workstation-to-Controller Communications:

1. Communication software on the workstation shall supervise the workstation-to-controller communications link during dial-up modem connect times.
2. Communication software shall be programmable to routinely poll each of the remote dial-up or cable modem Locations, collecting event logs and verifying phone lines at operator-selectable time intervals for each Location.

3. System shall be programmable for dialing and connecting to all dial-up or cable modem Locations and for retrieving the accrued history transactions on an automatic basis as often as once every [10] <Insert number> minutes and up to once every [9999] <Insert number> minutes.
  4. Failure to communicate to a dial-up Location three times in a row shall result in an alarm at the workstation.
  5. Time offset capabilities shall be present so that Locations in a different geographical time zone than the host workstation will be set to, and maintained at, the proper local time. This feature shall allow for geographical time zones that are ahead of or behind the host workstation.
  6. The controller connected to a dial-up or cable modem shall automatically buffer all normal transactions until its buffer reaches 80 percent of capacity. When the transaction buffer reaches 80 percent, the controller shall automatically initiate a call to the central station and upload all transactions.
  7. Alarms shall be reported immediately.
  8. Dial-up or cable modems shall be provided by manufacturer of the system. Modems used at the controller shall be powered by the controller. Power to the modem shall include battery backup if the controller is so equipped.
- I. Controller-to-Controller Communications:
1. TIA 485-A, four-wire, point-to-point, regenerative (repeater) communications network methodology.
  2. TIA 485-A communications signal shall be regenerated at each controller.
- J. Database Downloads:
1. All data transmissions from workstations to a Location, and between controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
  2. If a controller is reset for any reason, it shall automatically request and receive a database download from the workstation. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.
- K. Operator Interface:
1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
  2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
  3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
  4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
  5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
  6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

- a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
  - b. Maps to provide real-time display animation and allow for control of points assigned to them.
  - c. System to allow inputs, outputs, and override groups to be placed on different maps.
  - d. Software to allow changing the order or priority in which maps will be displayed.
7. Override Groups Containing I/Os:
- a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
  - b. Icon shall change automatically to show the live summary status of points in that group.
  - c. Override group icon shall provide a method to manually control or set to time-zone points in the group.
  - d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.
8. Schedule Overrides of I/Os and Override Groups:
- a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
  - b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
  - c. The first time and date shall be assigned the override state that the point shall advance to when the time and date become current.
  - d. The second time and date shall be assigned the state that the point shall return to when the time and date become current.
9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.
- L. Operator Access Control:
1. Control operator access to system controls through [**three**] <Insert number> password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
  2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
  3. A minimum of [**1024**] <Insert number> unique user accounts shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
  4. The password shall not be displayed or printed.
  5. Each password shall be definable and assignable for the following:
    - a. Selected commands to be usable.
    - b. Access to system software.

- c. Access to application software.
- d. Individual zones that are to be accessed.
- e. Access to database.

M. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than [**one**] <Insert number> second(s).
3. Tasks that are executed by operator's commands shall include the following:
  - a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
  - b. Place Zone in Access: Used to remotely disable intrusion-alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
  - c. Place Zone in Secure: Used to remotely activate intrusion-alarm circuits emanating from a specific zone.
  - d. System Test: Allows the operator to initiate a system-wide operational test.
  - e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
  - f. Print reports.
  - g. Change Operator: Used for changing operators.
  - h. Security Lighting Controls: Allows the operator to remotely turn on or turn off security lights.
  - i. Display Graphics: Used to show any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
  - j. Run system tests.
  - k. Generate and format reports.
  - l. Request help with the system operation.
    - 1) Include in main menus.
    - 2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
    - 3) Provide navigation to specific topic from within the first help window.
    - 4) Help shall be accessible outside the application program.
  - m. Entry-Control Commands:
    - 1) Lock (secure) or unlock (open) each controlled entry and exit up to [**four**] <Insert number> times a day through time-zone programming.
    - 2) Arm or disarm each monitored input up to [**four**] <Insert number> times a day through time-zone programming.
    - 3) Enable or disable readers or keypads up to [**two**] <Insert number> times a day through time-zone programming.
    - 4) Enable or disable cards or codes up to [**four**] <Insert number> times a day per entry point through access-level programming.

4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:
  - a. Command entered is incorrect or incomplete.
  - b. Operator is restricted from using that command.
  - c. Command addresses a point that is disabled or out of service.
  - d. Command addresses a point that does not exist.
  - e. Command is outside the system's capacity.

N. Alarms:

1. System Setup:
  - a. Assign manual and automatic responses to incoming-point status change or alarms.
  - b. Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound with use of WAV files; and maps or images that graphically represent the point location.
  - c. Sixty-character message field for each alarm.
  - d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages. Setup shall assign messages to [access point] [zone] [sensor] <Insert other alarm originating device>.
  - e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
  - f. Allow 25 secondary messages with a field of four lines of 60 characters each.
  - g. Store the most recent 1000 alarms for recall by the operator using the report generator.
2. Software Tamper:
  - a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
  - b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
  - c. Maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
  - d. Allow only acknowledgment of software tamper alarms.
3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.

6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
  7. Alarm Automation Interface: High-level interface to central-station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using a TIA 232-F ASCII interface.
  8. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
  9. Camera Control: Provides operator ability to select and control cameras from graphic maps.
- O. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
  2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
  3. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.
  4. Alarms initiate a status of "pending" and require the following two handling steps by operators:
    - a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
    - b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
  5. Each workstation shall display the total pending alarms and total unresolved alarms.
  6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
  7. Alarms shall transmit to the central station in real time except for allowing connection time for dial-up locations.
  8. Alarms shall be displayed and managed from a minimum of four different windows.
    - a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
    - b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
    - c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
    - d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
  9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.

10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
  11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
  12. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
  13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
  14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.
- P. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.
1. Color Code:
    - a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
    - b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
    - c. YELLOW: Advises operator that a zone is in access.
    - d. GREEN: Indicates that a zone is secure and that power is on.
  2. Graphics:
    - a. Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
    - b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
    - c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on the graphic map.
    - d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic maps associated with I/Os.
    - e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
    - f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
    - g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.
- Q. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.
1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.
- R. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be

the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.

1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of the period; and the default printer.
2. Printing on Request: An operator may request a printout of any report.
3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm [(**such as door alarm, intrusion alarm, tamper alarm, etc.**)] <Insert alarm types>, the type of sensor, the location, the time, and the action taken.
4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
10. Who Is "In" (Muster) Report:
  - a. Emergency Muster Report: One-click operation on toolbar launches report.
  - b. Cardholder Report. Contain a count of persons who are "In" at a selected Location and a detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.
11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
12. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events, or alarms only.
13. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.
  - a. Initially store history on the hard disk of the host workstation.
  - b. Permit viewing of the history on workstations or print history to any system printer.
  - c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
  - d. Each report shall depict the date, time, event type, event description, and device; or I/O name, cardholder group assignment, and cardholder name or code number.
  - e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.

- f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.
  14. Reports shall have the following four options:
    - a. View on screen.
    - b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to the system.
    - c. "Save to File" with full path statement.
    - d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.
  15. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:
    - a. Active, inactive, or future activate or deactivate.
    - b. Code number, name, or imprinted card number.
    - c. Group, Location access levels.
    - d. Start and stop code range.
    - e. Codes that have not been used since a selectable number of days.
    - f. In, out, or either status.
    - g. Codes with trace designation.
  16. The reports of system database shall allow options so that every data field may be printed.
  17. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.
- S. Anti-Passback:
1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
  2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.
  3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.
  4. Timed Anti-Passback: A controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.
  5. Provide four separate zones per Location that can operate without requiring interaction with the host workstation (done at controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.
  6. The anti-passback schemes shall be definable for each individual door.
  7. The Master Access Level shall override anti-passback.

8. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential-holder population anti-passback status to a neutral status.

T. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only those access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and name of person contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials issued to visitors.
5. Allow operator to recall visitors' credential-holder file once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

U. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.
2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.
3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.
  - a. Reports shall show in and out times for each day, total time in for each day, and a total time in for period specified by the user.
  - b. Allow the operator to view and print the reports, or save the reports to a file.
  - c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

- V. Training Software: Enables operators to practice system operation, including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

- W. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. The enrollment station shall not have alarm response or acknowledgment functions.
2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.

3. The program shall provide means to disable the enrollment station when it is unattended, to prevent unauthorized use.
4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity-verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
  - a. MASK: Determines a specific format with which data must comply.
  - b. REQUIRED: Operator is required to enter data into field before saving.
  - c. UNIQUE: Data entered must be unique.
  - d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
  - e. NAME ID: Data entered will be considered a unique ID for the cardholder.
6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
8. Batch card printing.
9. Default card data can be programmed to speed data entry for sites where most card data are similar.
10. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

## 2.6 SYSTEM DATABASE

- A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.
- B. Database Operations:
  1. System data management shall be in a hierarchical menu-tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
  2. Navigational Aids:
    - a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
    - b. Point and click feature to facilitate data manipulation.

- c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
    - d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.
  3. Data entry shall be automatically checked for duplicate and illegal data and shall be verified for valid format.
  4. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose for which the item was entered, reasons for changes that were made, and the like.
- C. File Management:
  1. File management shall include database backup and restoration system, allowing selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.
  2. Operations shall be both manual and automatic modes. The number of automatic sequential backups before the oldest backup will be overwritten; FIFO mode shall be operator selectable.
  3. Backup program shall provide manual operation from any workstation on the LAN and shall operate while system remains operational.
- D. Operator Passwords:
  1. Support up to [32,000] <Insert number> individual system operators, each with a unique password.
  2. [One to eight alphanumeric characters] <Insert password characteristic>.
  3. Allow passwords to be case sensitive.
  4. Passwords shall not be displayed when entered.
  5. Passwords shall have unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:
    - a. Predetermine the highest-level password profile for access to all functions and areas of program.
    - b. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
    - c. Restrict doors to which an operator can assign access.
  6. Operators shall use a user name and password to log on to system. This user name and password shall be used to access database areas and programs as determined by the associated profile.
  7. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.
- E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visible annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9999 that regulates the number of times the card can be used before it is automatically deactivated.
11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

F. Security Access Integration:

1. Photo ID badging and photo verification shall use the same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

G. Key control and tracking shall be an integrated function of cardholder data.

1. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
2. Reports shall be designed to list everyone who possesses a specified key.

H. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only at particular doors.

I. Operator Comments:

1. With the press of one appropriate button on the toolbar, the user shall be permitted to enter operator comments into the history at any time.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.

4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:
  - a. Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
  - b. Predefined and stored in database for retrieval on request.
6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

J. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign one of 32,000 group names to an access authorization.
3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

K. Time Zones:

1. Each zone consists of a start and stop time for seven days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
4. System shall have the capacity for [2048] <Insert number> time zones for each Location.

L. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time-zone schedule for that 24-hour period.
2. System shall have the capacity for [32,000] <Insert number> holidays.
3. Three separate holiday schedules may be applied to a time zone.
4. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in the system and will not be purged.
5. Holidays not designated to occur each year shall be automatically purged from the database after the date expires.

M. Access Levels:

1. System shall allow for the creation of up to [32,000] <Insert number> access levels.
2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
3. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
4. System shall be able to create multiple door and time-zone combinations under the same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same controller.

N. User-Defined Fields:

1. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include a search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

O. Code Tracing:

1. System shall perform code tracing selectable by cardholder and by reader.
2. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
3. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
4. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the central station shall be highlighted with a different color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
5. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

## 2.7 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
  2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.8 CENTRAL-STATION HARDWARE

- A. Central-Station Computer: Standard workstation of modular design.
- B. Redundant Central Computer: One identical redundant central computer, connected in a hot standby, peer configuration. This computer shall automatically maintain its own copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real time. If central computer fails, redundant computer shall assume control immediately and automatically.
- C. Desktop Workstations:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Performance Requirements:
    - a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
    - b. Capable of running [Microsoft Windows] <insert operating system name>.
    - c. Energy Star compliant.
    - d. Processor:
      - 1) Minimum Speed: <Insert gigahertz>.
      - 2) Cores: [Single] [Dual] [Quad] <insert number>.
      - 3) Series: [Core i3] [Core i5] [Core i7] <insert type>.
    - e. RAM:
      - 1) Capacity: [2] [4] [8] <Insert value> [GB].
      - 2) Speed and Type: [1333] <Insert value> MHz, <Insert type>.
    - f. Primary Hard Drive:
      - 1) Media: [Solid state] [Rotating disc, nominal rotational speed of 7200 rpm] [Hybrid solid-state and rotating disc].
      - 2) Number of Hard Drives: [One] [Two] <Insert number>.
      - 3) Capacity: <Insert number> [GB] [TB].

- 4) Minimum Average Seek Time: <Insert number and measurement unit>.
  - 5) Cache Buffer Size: <Insert number and measurement unit>.
  - 6) <Insert requirements>.
- g. Second Hard Drive:
- 1) Media: [Solid state] [Rotating disc, nominal rotational speed of 7200 rpm] [Hybrid solid-state and rotating disc].
  - 2) Capacity: <Insert number and measurement unit>.
  - 3) Minimum Average Seek Time: <Insert number and measurement unit>.
  - 4) Cache Buffer Size: <Insert number and measurement unit>.
  - 5) <Insert requirements>.
- h. Optical Drive:
- 1) Type: <Insert type>.
  - 2) Minimum Average Access Time: <Insert number> ms.
  - 3) Data Transfer Speed: <Insert number> [MB] [GB]/s.
  - 4) Reading Formats: Data, audio, recordable, <Insert other> and rewritable.
- i. Optical Read and Write Drive:
- 1) Include with at least 2 MB of data buffer.
  - 2) Type: <Insert type>.
  - 3) Minimum Data Buffer Capacity: <Insert number and measurement unit>.
  - 4) Minimum Average Access Time: <Insert number> ms.
  - 5) Nominal Data Transfer Rates:
    - a) Reading: <Insert number> [MB] [GB]/s.
    - b) Writing: <Insert number> [MB] [GB]/s.
  - 6) Average access time of 150 ms or less.
  - 7) MTBF of at least 100,000 power-on hours.
- j. Expansion slots: Minimum of 4, [32] [64] <Insert number> bit.
- k. Video Card:
- 1) Capable of supporting [one] [two] [three] [four] monitors.
  - 2) Resolution: [1920 by 1200] <Insert values> pixels minimum for each monitor.
  - 3) RAM: <Insert number> GB.
  - 4) Controller Speed: <Insert number> [MHz] [GHz].
  - 5) On-Board Memory Speed: <Insert number> [MHz] [GHz].
  - 6) On-Board Memory Data Width: <Insert number> bit.
- l. Sound Card:
- 1) At least 128 voice wavetable synthesis.
  - 2) Capable of delivering three-dimensional sound effects.

- 3) High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
  - m. Network Interface Card: Include card with connection, as applicable.
    - 1) 10-100-1000 base TX Ethernet with RJ45 connector port.
    - 2) 100 base FX Ethernet with SC or ST port.
  - n. Wireless Ethernet, 802.11 a/b/g/n.
  - o. Optical Modem: Full duplex link for connection to optical fiber cable provided.
  - p. I/O Ports:
    - 1) Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    - 2) One serial port.
    - 3) One parallel port.
    - 4) Two PS/2 ports.
    - 5) One RJ-45.
    - 6) One stereo line-in and line-out on back panel.
    - 7) One microphone and headphone connector on front panel.
    - 8) One IEEE 1394 on front and back panel with workstation I-e card.
    - 9) One ESATA port on back panel.
  - q. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.
3. Keyboard:
    - a. 101 key enhanced keyboard.
    - b. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
    - c. Wireless operation within up to **72 inches (1800 mm)** in front of workstation.
  4. Pointing Device:
    - a. Either a two- or three-button mouse.
    - b. Wireless operation within up to **72 inches (1800 mm)** in front of workstation.
  5. Flat Panel Display Monitor:
    - a. Number of Displays: **[One] [Two] <Insert number>**.
    - b. Display Support: **[Individual tilt adjustable base.] [Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization.] [Wall mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization.] <Insert description.>**
    - c. Color display with **<Insert inches (mm)>** diagonal viewable area.
    - d. Aspect Ratio: **[16 to 9] <Insert value>**.
    - e. Resolution: **[1920 by 1080] <Insert value>** pixels at 60 Hz with pixel size of **[0.277] <Insert number>** mm or smaller.
    - f. **[Digital] [or] [analog]** input signal.

- g. Response Time: **<Insert number>** ms.
  - h. Dynamic Contrast Ratio: **[50000 to 1]** **<Insert ratio>**.
  - i. Brightness: **[250 cd/sq. m]** **<Insert value>**.
  - j. Energy Star compliant.
  - k. Antiglare display.
6. Speakers:
- a. Two, with individual controls for volume, bass and treble.
  - b. Signal to Noise Ratio: At least 65 dB.
  - c. Power: At least 4 W per speaker/channel.
  - d. Magnetic shielding to prevent distortion on the video monitor.
7. I/O Cabling: Include applicable cabling to connect I/O devices.
8. Software:
- a. Factory installed operating system.
- D. Portable Workstations:
- 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  - 2. Performance Requirements:
    - a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
    - b. Energy Star compliant.
    - c. Hardware and software shall support local down-loading to DDC controllers.
    - d. Data transfer rate to DDC controller shall be at network speed.
  - 3. Processor:
    - a. Minimum Speed: **<Insert gigahertz>**,
    - b. Cores: **[Single] [Dual] [Quad]** **<Insert number>**.
    - c. Series: **[Core i3] [Core i5] [Core i7]** **<Insert type>**.
  - 4. RAM:
    - a. Capacity: **<Insert value>** **[GB] [TB]**.
    - b. Speed and Type: **<Insert value>** MHz, **<Insert type>**.
  - 5. Hard Drive:
    - a. Media: **[Solid state] [Rotating disc, nominal rotational speed of 7200 rpm] [Hybrid solid-state and rotating disc]**.
    - b. Number of Hard Drives: **[One] [Two]** **<Insert number>**.
    - c. Capacity: **<Insert number and measurement unit>**.
    - d. Minimum Average Seek Time: **<Insert number and measurement unit>**.
    - e. Cache Buffer Size: **<Insert number and measurement unit>**.
    - f. **<Insert requirements>**.
  - 6. Video Card: **<Insert number and measurement unit>** of RAM.

7. Input and Output Ports:
  - a. Serial port.
  - b. Shared port for external keyboard or mouse.
  - c. Four USB 3.0 ports.
  - d. Ethernet port.
  - e. HDMI port.
  - f. IEEE 1394 port.
8. Battery:
  - a. Capable of supporting operation of portable workstation for a minimum of **[8]** **<insert number>** hours.
  - b. Battery life of at least three years.
  - c. Battery charge time of less than three hours.
  - d. Spare Batteries: **[One]** **[Two]**.
9. Keyboard:
  - a. 85-key **[backlit]** keyboard.
  - b. Full upper- and lowercase ASCII keyset.
10. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.
11. Display:
  - a. **<Insert inches (mm)>** diagonal or larger high-definition WLED color display.
  - b. Antiglare screen.
  - c. **[1920 by 1080]** **<Insert value>** pixel resolution.
  - d. Brightness: 300 nits.
12. Network Interfaces:
  - a. Network Interface Card: Include card with connection, as application.
    - 1) 10-100-1000 base TX Ethernet with RJ45 connector port.
    - 2) 100 base FX Ethernet with SC or ST port.
  - b. Wireless:
    - 1) Internal with integrated antenna, capable of supporting 802.11 a/b/g/n.
13. Digital Video Disc Rewrite Recorder (DVD+/-RW):
  - a. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
  - b. Nominal Data Transfer Rates:
    - 1) Reading: **<Insert number>** **[MB]** **[GB]/s.**
    - 2) Writing: **<Insert number>** **[MB]** **[GB]/s.**
  - c. 160-ms access time.

## 14. Accessories:

- a. Nylon carrying case.
- b. Docking station.
- c. Mobile broadband card.
- d. Wireless optical mouse.
- e. <Insert value> [GB] [TB] portable hard drive.
- f. Light-sensitive Web cam and noise-cancelling digital array microphone.
- g. Category 6a patch cable. Minimum cable length shall be <Insert length>.
- h. HDMI cable. Minimum cable length shall be <Insert length>.

## E. Servers:

1. Description: x86 based computer used for client-server computing.
2. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
3. Mounting: [Rack] [blade] [tower] [tower able to rack-mounted].
4. Power: [Single] [dual] power supply, minimum 300 W.
5. Performance Requirements:
  - a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
  - b. Energy Star compliant.
6. Processor:
  - a. Minimum Speed: <Insert gigahertz>.
  - b. Cores: [Single] [Dual] [Quad] <insert number>.
  - c. Series: [Core i3] [Core i5] [Core i7] <insert type>.
7. RAM:
  - a. Capacity: <Insert value> [GB] [TB].
  - b. Speed and Type: <Insert value> MGz, <Insert type>.
  - c. Expandable Capacity: <Insert value> [GB] [TB].
8. Redundant Array of Independent Disks: [Zero] [One] [Two] [Three] [Four] [Five] <Insert number> configuration.
9. Drive Bays: Eight at 2.5 inches (65 mm) or eight at 3.5 inches (90 mm). [Hot swappable.]
10. Hard Drives: [Solid state.] [Rotating disc, nominal rotational speed of 7200 rpm.]
11. Hard-Drive Storage: [Two] [Three] [Four] drives each with <Insert value> [GB] [TB] storage.
12. Network Interface: [Dual port Gigabit Ethernet] [Optical fiber].
13. DVD +RW Drive.
14. Color, flat-screen display with <Insert inches (mm)> diagonal viewable area.
15. Keyboard and mouse.
16. Next-day on-site warranty for [two] [three] <Insert number>-year period following Substantial Completion.
17. Servers shall include the following:
  - a. Full-feature backup server (server and backup minimum requirement).

- b. Software licenses.
  - c. Cable installation between server(s) and network.
18. Web Server:
- a. If required to be separate, include Web server hardware and software to match, except backup server is not required.
  - b. Firewalls between server Web and networks.
  - c. Password protection for access to server from Web server.
  - d. Cable installation between the server(s) and building Ethernet network.
19. Power each server through a [**dedicated**]UPS unit.
- F. Printers:
1. Black and White Laser Printer:
- a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  - b. [1200 by 1200] <Insert value> dots per inch resolution.
  - c. First sheet printed within 10 seconds.
  - d. <Insert number> page per minute rated print speed at best quality mode.
  - e. Print buffer with at least <Insert value> MB of RAM, expandable to at least 288 MBs.
  - f. Complies with Energy Star requirements.
  - g. Capable of handling letter- and legal-size paper and overhead transparencies.
  - h. Two paper trays; one tray with <Insert number> sheet capacity, and one tray with <Insert number> sheet capacity.
  - i. At least <Insert number> page toner/cartridge capacity.
2. Color Laser Printer:
- a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  - b. [1200 by 1200] <Insert value> dots per inch resolution black and white, [1200 by 1200] <Insert value> dots per inch resolution black and white and color.
  - c. First sheet printed within 10 seconds.
  - d. <Insert number> page per minute rated print speed at best quality mode.
  - e. Print buffer with at least [512] <Insert value> MB of RAM, expandable to at least [one] <Insert value> GB.
  - f. Complies with Energy Star requirements.
  - g. Capable of handling letter- and legal-size paper and overhead transparencies.
  - h. Two paper trays; one tray with <Insert number> sheet capacity, and one tray with 500 <Insert number> sheet capacity.
  - i. Two-sided printing.
  - j. At least <Insert number> page toner/cartridge capacity.
3. Color Inkjet Printer:
- a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- b. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
- c. Print quality of [1200 by 600] <Insert value> dots per inch with black on inkjet paper and [4800 by 1200] <Insert value> dots per inch color printing on premium photo paper.
- d. Rated speed of <Insert number> pages per minute printing black and white in normal mode and <Insert number> pages per minute printing color in normal mode.
- e. Two paper trays; one tray with <Insert number> sheet capacity, and one tray with <Insert number> sheet capacity.
- f. Capable of handling letter- and legal-size paper and overhead transparencies.
- g. <Insert number> MB of RAM.
- h. Duplex printing (printing on both sides of paper).

4. Dot Matrix Printer:

- a. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- b. Letter-quality, wide-carriage, 24-pin dot matrix printer.
- c. <Insert number> kb print buffer.
- d. Minimum Print Speed:
  - 1) 330 characters per second (draft).
  - 2) 110 characters per second (letter quality).
- e. Seven print fonts.
- f. Continuous - forms feed with manual single sheet feed.
- g. Capable of handling 16-inch- (400-mm-) wide continuous-feed paper.

2.9 FIXED MAP DISPLAY

- A. A fixed map display shall show layout of the protected facilities. Zones corresponding to those monitored by the system shall be highlighted on the display. Status of each zone shall be displayed using digital displays as required within each designated zone. A digital display test switch shall be provided on the map display.

2.10 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Alarm Annunciation Controller:

1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network[, **with dc line supervision on each of its alarm inputs**].
    - a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
    - b. Alarm-Line Supervision:
      - 1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal[, **and for conditions as described in UL 1076 for line security equipment**] [**by monitoring for abnormal open, grounded, or shorted conditions**] using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of [5] [10] percent or more for longer than 500 ms.
      - 2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.
    - c. Outputs: Managed by central-station software.
  2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.
- E. Entry-Control Controller:
1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
    - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
    - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
      - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
      - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
    - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
  2. Inputs:
    - a. Data from entry-control devices; use this input to change modes between access and secure.

- b. Database downloads and updates from the central station that include enrollment and privilege information.
3. Outputs:
    - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    - b. Grant or deny entry by sending control signals to portal-control devices[ **and mask intrusion-alarm annunciation from sensors stimulated by authorized entries**].
    - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
    - d. Door Prop Alarm: If a portal is held open for longer than [**20 seconds**] [**time listed in a schedule**], alarm sounds.
  4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
  5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
    - a. Store up to [**1000**] **<Insert number>** transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
  6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
    - a. Backup Battery: [**Premium, valve**] [**Valve**]-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata [**19**] [**9**]-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
    - b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
    - c. Backup Power-Supply Capacity: [**Five**] [**90**] minutes of battery supply. Submit battery and charger calculations.
    - d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
      - 1) Trouble Alarm: Normal power-off load assumed by battery.
      - 2) Trouble Alarm: Low battery.
      - 3) Alarm: Power off.

## 2.11 SECONDARY ALARM ANNUNCIATOR

- A. Secondary Alarm Annunciation Site: A workstation with limited I/O capacity, consisting of a secondary alarm annunciation workstation **[to allow the operator to duplicate functions of the main operator interface and to show system status changes] [to display alarms or system status changes only]**.

## 2.12 ENROLLMENT CENTER

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Equipment for enrolling personnel into, and removing personnel from, system database, using a dedicated desktop workstation
  1. Include equipment to enroll selected biometric credentials.
- C. Enrollment equipment shall support encoding of credential cards including cryptographic and other internal security checks as required for system.
  1. Allow only authorized entry-control enrollment personnel to access the enrollment equipment using passwords.
  2. Include enrollment-subsystem configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the central station.
  3. Enrollment-station records printer shall meet requirements of the report printer.
- D. Entry-Control Enrollment Software:
  1. Shall include database management functions for the system, and shall allow an operator to change and modify the data entered in the system as needed.
  2. Software shall not have alarm response or acknowledgment functions as a programmable function.
  3. Multiple, password-protected access levels shall be provided at the enrollment station.
  4. Database management and modification functions shall require a higher operator-access level than personnel enrollment functions.
  5. Software shall provide a means for disabling the enrollment station when it is unattended, to prevent unauthorized use.
  6. Software shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations to include a credential unit in use at the installation.
  7. In the case of personnel identity-verification subsystems, this data shall include biometric data.
  8. Software shall allow entry of this data into the system database files through the use of simple menu selections and data fields. The data field names shall be customized to suit user and site needs.
  9. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
- E. Accessories:

1. Steel desk-type console, swivel chair on casters, and equipment racks.
  2. Console and Equipment Racks: Comply with EIA/ECA-310-E.
  3. Equipment, with the exception of the printers, shall be rack mounted in the console and equipment racks.
  4. Storage Cabinet: Locking cabinet approximately **72 inches (1830 mm)** high, **36 inches (915 mm)** wide, and **24 inches (610 mm)** deep, with three adjustable shelves and two storage racks.
- F. System Capacity: Number of badges shall be limited only by hard disk space. Badge templates and images shall be in color, supporting the maximum color capability of workstation operating system.
- G. Badge Configuration:
1. Software for badge template creation shall include a template consisting of background and predetermined locations of photographs, text objects and data fields for text, and bar-code and biometric information. Include automatic sizing of data fields placed on a badge to compensate for names, which may otherwise be too large to fit in the area designated.
  2. Allow different badge templates to be used for each department, tenant, or visitor.
  3. As a setup option, templates shall be automatically selected for the badge, based on the group to which the credential holder is assigned. Allow the operator to override the automatic template selection and use a template chosen by the operator for creating a badge.
  4. Setup shall determine which graphics and credential-holder information will be displayed and where on the card it will be placed. All data in the security access system, such as name, code, group, access level, and any of the 99 user-defined fields, shall be selectable, with the ability to place them anywhere on the card.
  5. System shall include an importing, filing, and recall system of stored images and shapes that can be placed on the badge.
  6. Allow multiple images on the same badge, including, but not limited to, bar codes, digital photos, and signatures.
  7. Support transparent backgrounds so that image is only surrounded by the intended background and not by its immediate background.
- H. Photo Imaging: Integral to security access.
1. Import images from bitmap file formats, digital cameras, TWAIN cameras, or scanners. Allow image cropping and editing, WYSIWYG badge-building application, and badge print-preview and printing capabilities.
  2. System shall support multiple images stored for each credential holder, including signatures, portrait views, and profile views.
- I. Text Objects: Badge configuration shall provide for creation of custom text as an object, allowing font selection, typing, scaling, and formatting of the text object. Formatting options shall include changing font, font size, text flow, and text alignment; bending or curving the text object into a circle or semicircle; applying 3-D effects; and applying predefined effects such as tilt, extrusion, or beveling. Text shall be placed and optionally automatically centered within any region of the badge layout.
- J. Badges and Credential Cards:

1. Badges are credential cards that do not contain data to be read by card readers.
  2. Credential cards shall store uniquely coded data used by card readers as an Identifier.
    - a. Magnetic-Stripe Cards: Comply with ISO/IEC 7810, ISO/IEC 7811-1, ISO/IEC 7811-2, ISO/IEC 7811-6, and ISO/IEC 7811-7. Use single-layer magnetic tape material that is coated with a plastic, slick protective coat and affixed to the back of the credential card near the top.
    - b. Wiegand Wire-Effect Cards: Ferromagnetic wires laminated into the credential card using binary digits specified for Wiegand readers to generate a unique credential card identification code.
    - c. Proximity [**Cards**] [**Key Fobs**]: Use proximity detection without physical contact with the reader for proper operation.
  3. Allow entry-control card to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge without reduction of readability. The design shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type of badge holder used at the site.
    - a. Card Size and Dimensional Stability: Standard size, [**2-1/8 by 3-3/8 inches (54 by 86 mm)**] <Insert dimensions>; dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.
    - b. Card Material: Abrasion resistant, nonflammable, and nontoxic; and impervious to solar radiation and effects of ultraviolet light.
    - c. Card Construction: Core and laminate or monolithic construction. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.
      - 1) Incorporate [**holographic images**] [**phosphorous ink**] as a security enhancement.
      - 2) Furnish equipment for on-site assembly and lamination of credential cards.
    - d. Card Durability and Maintainability: Designed and constructed to yield a useful lifetime of at least five years or 5000 insertions or swipes, whichever results in a longer period of time. Allow credential cards to be cleaned by wiping with a sponge or cloth wetted with soap and water.
- K. Card-Making Equipment: Consisting of a workstation, video camera, video-imaging equipment, and a printer.
1. Camera: NTSC color standard, RGB video output, 470 lines minimum horizontal resolution, and automatic white balance with full rated output under illumination of **0.5 fc (5 lx)**.
  2. Video Imaging: Live-image capture software and hardware and a digital signature capture pad.
  3. Standard workstation, modified as follows:
    - a. Redundant workstation is not required.
    - b. Printer is not required.
    - c. UPS is not required.
    - d. Sound card is not required.

4. Printer: Dye-sublimation resin thermal transfer, [300] <Insert number> dpi resolution, 16.7 million colors, accepting cards ranging in size from 2.1 by 3 inches to 2.6 by 3.7 inches (53 by 76 mm to 66 by 94 mm) and having card thickness ranging from 0.020 to 0.060 inch (0.5 to 1.5 mm). Printer shall have options for encoding magnetic stripe using tracks 1, 2, and 3. Throughput shall be not less than [60] <Insert number> seconds per card.

## 2.13 DOOR AND GATE HARDWARE INTERFACE

- A. Exit Device with Alarm: Operation of the exit device shall generate an alarm[ **and annunciate a local alarm**]. Exit device and alarm contacts are specified in Section 087100 "Door Hardware."
- B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."
- C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."
- D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Section 087100 "Door Hardware."
- E. Vehicle Gate Operator: Interface electrical operation of gate with controls in this Section. Vehicle gate operators shall be connected, monitored, and controlled by the security access controllers. Vehicle gate and accessories are specified in Section 323113 "Chain Link Fences and Gates."

## 2.14 FIELD-PROCESSING SOFTWARE

- A. Operating System:
  1. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
  2. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
  3. Execution of local processor application programs shall utilize the data in memory resident files.
  4. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
  5. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).
- B. Startup Software:

1. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
2. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
3. Initiates operation of self-test diagnostic routines.
4. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
5. If the database and application programs are resident, the local processor shall immediately resume operation.

C. Operating Mode:

1. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
2. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
3. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
4. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
5. Local processors shall accept software downloaded from the central station.
6. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.

D. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.

E. Functions:

1. Monitoring of inputs.
2. Control of outputs.
3. Reporting of alarms automatically to the central station.
4. Reporting of sensor and output status to central station upon request.
5. Maintenance of real time, automatically updated by the central station at least once a day.
6. Communication with the central station.
7. Execution of local processor resident programs.
8. Diagnostics.
9. Download and upload data to and from the central station.

## 2.15 FIELD-PROCESSING HARDWARE

A. Alarm Annunciation Local Processor:

1. Respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.

2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
4. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
5. Local processor shall report line supervision alarms to the central station.
6. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 milliseconds.
7. Alarm condition shall be transmitted to the central computer during the next interrogation cycle.
8. Local processor outputs shall reflect the state of commands issued by the central station.
9. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
10. Local processor shall have at least four command outputs.
11. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.

B. Processor Power Supply:

1. Local processor and sensors shall be powered from an uninterruptible power source.
2. Uninterruptible power source shall provide eight hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored.
3. If the facility is without an emergency generator, the uninterruptible power source shall provide 24 hours of battery backup power.
4. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa.
5. Batteries shall be sealed, non-outgassing type.
6. Power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.
7. Loss of primary power shall be reported to the central station as an alarm.

C. Auxiliary Equipment Power: A GFI service outlet shall be furnished inside the local processor's enclosure.

D. Entry-Control Local Processor:

1. Entry-control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Entry-control local processor shall provide local entry-control functions including communicating with field devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.

4. Processor shall also accept data from entry-control field devices as well as database downloads and updates from the central station that include enrollment and privilege information.
5. Processor shall send indications of successful or failed attempts to use entry-control field devices and shall make comparisons of presented information with stored identification information.
6. Processor shall grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
7. Entry-control local processor shall use inputs from entry-control devices to change modes between access and secure.
8. Local processor shall maintain a date-time- and location-stamped record of each transaction and transmit transaction records to the central station.
9. Processor shall operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the local processor and the central station.
10. Processor shall store a minimum of 4000 transactions during periods of communication loss between the local processor and the central station for subsequent upload to the central station upon restoration of communication.
11. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
12. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
13. Local processor shall report line supervision alarms to the central station.
14. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 ms.
15. Alarm condition shall be transmitted to the central station during the next interrogation cycle.
16. Entry-control local processor shall include the necessary software drivers to communicate with entry-control field devices. Information generated by the entry-control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal.
17. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges.
18. Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time- and location-stamped record of each transaction.
19. Transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
20. Local processor outputs shall reflect the state of commands issued by the central station.
21. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
22. Local processor shall have at least four addressable outputs.
23. The entry-control local processor shall also provide control outputs to portal-control devices.
24. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.
25. The system manufacturer shall provide strategies for downloading database information for panel configurations and cardholder data to minimize the required download time when using IP connectivity.

## 2.16 TIA 232-F ASCII INTERFACE SPECIFICATIONS

- A. ASCII interface shall allow TIA 232-F connections to be made between the control station operating as the host workstation and any equipment that will accept TIA 232-F ASCII command strings, such as CCTV switches, intercoms, and paging systems.
1. Alarm inputs in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host workstation.
  2. Inputs shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm, abnormal condition and one for a normal condition through the same or different COM port.
  3. Predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. Character strings shall be defined in the system database and then assigned to the appropriate inputs.
  4. COM ports of the host workstation used to interface with external equipment shall be defined in the setup portion of the software. COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.
- B. Pager-System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
1. TIA 232-F output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.
- C. Alarm-System Interface:
1. TIA 232-F output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
  2. Alternatively, alarms that are received by this access-control system are to be transferred to the alarm automation system as if they were sent through a digital alarm receiver.
    - a. System shall be able to transmit an individual message from any alarm input to a burglar-alarm automation monitoring system.
    - b. System shall be able to append to each message a predefined set of character strings as a prefix and a suffix.

## 2.17 FLOOR-SELECT ELEVATOR CONTROL

- A. Elevator access control shall be integral to security access.
1. System shall be capable of providing full elevator security and control through dedicated controllers without relying on the control-station host workstation for elevator control decisions.
  2. Access-control system shall enable and disable car calls on each floor and floor-select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.

3. System setup shall, through programming, automatically and individually secure and unsecure each floor-select button of a car by time and day. Each floor-select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
  4. When a floor-select button is secure, it shall require the passenger to use his or her access code and gain access to that floor before the floor-select button will operate. The passenger's credential shall determine which car call and floor-select buttons are to be enabled, restricting access to floors unless authorized by the system's access code database. Floor-select button shall be enabled only in the car where the credential holder is the passenger.
- B. Security access system shall record which call button is pressed, along with credential and time information.
1. System controller shall record elevator access data.
  2. The controller shall reset all additional call buttons that may have been enabled by the user's credential.
  3. The floor-select elevator control shall allow for manual override from a workstation workstation either by individual floor or by cab.

## 2.18 REAL-TIME GUARD TOUR

- A. Guard tour module shall provide the ability to plan, track, and route tours. Module shall input an alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour-station order.
1. Guard tour setup shall define specific routes or tours for the guard to take, with time restrictions in which to reach every predefined tour station.
  2. Guard tour activity shall be automatically logged to the central-station workstation's hard drive.
  3. If the guard is early or late to a tour station, a unique alarm per station shall appear at the central station to indicate the time and station.
  4. Guard tour setup shall allow the tours to be executed sequentially or in a random order with an overall time limit set for the entire tour instead of individual times for each tour station.
  5. Setup shall allow recording of predefined responses that will display for the operator at the control station should a "Failed to Check In" alarm occur.
- B. Guard tour module shall allow proprietary direct-connected systems to use security access-control hardware to perform guard tour management in real time.
- C. A tour station is a physical location where a guard shall go and perform an action indicating that he or she has arrived. This action, performed at the tour station, shall be one of 13 different events with any combination of station types within the same tour. An event at a tour station shall be one of the following types:
1. Access Granted.
  2. Access Denied Code.
  3. Access Denied Card plus PIN.
  4. Access Denied Time Zone.

5. Access Denied Level.
6. Access Denied Facility.
7. Access Denied Code Timer.
8. Access Denied Anti-Passback.
9. Access Granted Passback Violation.
10. Alarm.
11. Restored.
12. Input Normal.
13. Input Abnormal.

- D. Guard tour and other system features shall operate simultaneously with no interference.
- E. Guard Tour Module Capacity: 999 possible guard tour definitions with each tour having up to 99 tour stations. System shall allow all 999 tours to be running at the same time.

## 2.19 VIDEO AND CAMERA CONTROL

- A. Control station or designated workstation displays live video from a CCTV source.
1. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom-command auxiliary controls.
  2. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
  3. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.
- B. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall automatically send control commands through a COM port to display the requested camera when the camera icon is selected.
- C. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

## 2.20 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

## 2.21 CABLE AND ASSET MANAGEMENT SOFTWARE

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Computer-based cable and asset management system, with fully integrated database and graphic capabilities, complying with requirements in TIA 606-B.

1. Document physical characteristics by recording the network, asset, user, TIA details, device configurations, and exact connections between equipment and cabling.
    - a. Manage the physical layer of security system.
    - b. List device configurations.
    - c. List and display circuit connections.
    - d. Record firestopping data.
    - e. Record grounding and bonding connections and test data.
  2. Information shall be presented in database view, schematic plans, or technical drawings.
    - a. Microsoft Visio Technical Drawing shall be used as drawing and schematic plans software. Drawing symbols, system layout, and design shall comply with SIA/IAPSC AG-01.
  3. System shall interface with the following testing and recording devices:
    - a. Direct-upload tests from circuit testing instrument into the workstation.
    - b. Direct-download circuit labeling into labeling printer.
- C. Software shall be designed for <Insert type of software and version> of the same version as security access system's central station and workstations and shall be installed on the designated workstation, using a hard drive dedicated only to this management function.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

1. Record setup data for control station and workstations.
  2. For each Location, record setup of controller features and access requirements.
  3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
  4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
  5. Assign action message names and compose messages.
  6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  7. Prepare and install alarm graphic maps.
  8. Develop user-defined fields.
  9. Develop screen layout formats.
  10. Propose setups for guard tours and key control.
  11. Discuss badge layout options; design badges.
  12. Complete system diagnostics and operation verification.
  13. Prepare a specific plan for system testing, startup, and demonstration.
  14. Develop acceptance test concept and, on approval, develop specifics of the test.
  15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format <Insert software>.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

### 3.3 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

### 3.4 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
  - 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
  - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

### 3.6 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

### 3.7 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
  - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  - 3. Security personnel.
  - 4. Hardware maintenance personnel.
  - 5. Corporate management.

END OF SECTION 281300

## SECTION 312319 - DEWATERING

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes construction dewatering.
- B. Related Requirements:
  - 1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
  - 2. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

## 1.3 ALLOWANCES

- A. Dewatering observation wells are part of [**dewatering**] <Insert description> allowance.

## 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [**Project site**] <Insert location>.
  - 1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
  - 3. Review geotechnical report.

4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

## 1.5 ACTION SUBMITTALS

- A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.
  1. Include plans, elevations, sections, and details.
  2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
  3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
  4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Installer]** **[land surveyor]** **[and]** **[professional engineer]**.
- B. Field quality-control reports.
- C. Existing Conditions: Using **[photographs]** **[or]** **[video recordings]**, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.
- D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in **[design of dewatering systems and ]**dewatering work.

## 1.8 FIELD CONDITIONS

- A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
  1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
  2. The geotechnical report is **[included]** **[referenced]** elsewhere in Project Manual.

- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - 1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
  - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
  - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - 5. Remove dewatering system when no longer required for construction.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
  - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls, which are specified in [Section 015000 "Temporary Facilities and Controls,"] [Section 311000 "Site Clearing,"] during dewatering operations.

### 3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

### 3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
  - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - 3. Maintain piezometric water level a minimum of [24 inches (600 mm)] [60 inches (1500 mm)] <Insert dimension> below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

### 3.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
  - 1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
  - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**] [**monthly**] <Insert time period> during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.
- C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- D. Prepare reports of observations.

### 3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

## SECTION 321313 - CONCRETE PAVING

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

**Access Manufacturer-Provided, AIA MasterSpec-Based Sections:**

[<Double click here for this Section based on specific manufacturer's products set as Basis-of-Design at ProductMasterSpec.com.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes Concrete Paving [.] [**Including the Following:**]

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

- B. Related Requirements:

1. [**Section 033000 "Cast-in-Place Concrete"**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete"**] for general building applications of concrete.
2. Section 321316 "Decorative Concrete Paving" for stamped concrete other than stamped detectable warnings.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
4. Section 321713 "Parking Bumpers."
5. Section 321723 "Pavement Markings."

6. Section 321726 "Tactile Warning Surfacing" for detectable warning [**tiles**] [**mats**] [**and**] [**pavers**].
7. Section 321729 "Manufactured Traffic-Calming Devices."

### 1.3 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.

### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [**Project site**] <Insert location>.
  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.
    - c. <Insert agenda item>.
  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.

### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  1. <Double click to insert sustainable design text for recycled content.>
  2. <Double click to insert sustainable design text for regional materials.>
  3. <Double click to insert sustainable design text for solar reflectance.>
- C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
  1. Exposed Aggregate: [**10-lb (4.5-kg)**] <Insert weight> Sample of each mix.

- E. 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.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified [**Installer of stamped detectable warnings**] [**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.

## 1.7 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 shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [**96 inches (2400 mm)** by **96 inches (2400 mm)**] <Insert dimensions>.[ **Include full-size detectable warning.**]
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect 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.

## 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

## 1.9 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 (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F (10 deg C)** and not more than **80 deg F (27 deg C)** 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 (ACI 301M)** and as follows when hot-weather conditions exist:
  1. Cool ingredients before mixing to maintain concrete temperature below **90 deg F (32 deg C)** 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

## 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.

## 2.2 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 (30.5 m)** or less. [ **Do not use notched and bent forms.** ]
- 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.

## 2.3 STEEL REINFORCEMENT

- A. [<Double click to insert sustainable design text for recycled content of steel products.>](#)
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from [**as-drawn**] [**galvanized**]-steel wire into flat sheets.
- C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- D. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- E. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.
- F. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars.
- G. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars.
- H. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, **Grade 60 (Grade 420)** deformed bars; assembled with clips.
- I. Plain-Steel Wire: ASTM A1064/A1064M, [**as drawn**] [**galvanized**].
- J. Deformed-Steel Wire: ASTM A1064/A1064M.
- K. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, [**plain**] [**deformed**].
- L. Joint Dowel Bars: ASTM A615/A615M, **Grade 60 (Grade 420)** 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.

- M. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, **Grade 60 (Grade 420)** plain-steel bars.
- N. Tie Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**; deformed.
- O. Hook Bolts: **ASTM A307, Grade A (ASTM F568M, Property Class 4.6)**, 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.
- P. 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.
- Q. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- R. Zinc Repair Material: ASTM A780/A780M.

## 2.4 CONCRETE MATERIALS

- A. [<Double click to insert sustainable design text for regional materials \(concrete\).>](#)
- B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, [**gray**] [**white**] portland cement [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**].
  - 2. Fly Ash: ASTM C618, [**Class C**] [**or**] [**Class F**].
  - 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
  - 4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type IL, Portland-limestone**] [**Type IT, ternary blended**] cement.
- C. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**] [**Class 4M**] [**Class 1N**] **<Insert class>**, 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 (38 mm)**] [**1 inch (25 mm)**] [**3/4 inch (19 mm)**] nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- D. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
1. Aggregate Sizes: [**3/4 to 1 inch (19 to 25 mm)**] [**1/2 to 3/4 inch (13 to 19 mm)**] [**3/8 to 5/8 inch (10 to 16 mm)**] <Insert dimensions> nominal.
  2. Aggregate Source, Shape, and Color: <Insert requirements>.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. 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.
- G. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, [**free of carbon black,**] nonfading, and resistant to lime and other alkalis.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- H. Water: Potable and complying with ASTM C94/C94M.

## 2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: 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 (13 to 38 mm)**] <Insert dimensions> long.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Synthetic Fiber: 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 (13 to 38 mm)**] <Insert dimensions> long.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, [**Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) 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.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.7 RELATED MATERIALS

- A. Joint Fillers: [**ASTM D1751, asphalt-saturated cellulosic fiber**] [or] [**ASTM D1752, cork or self-expanding cork**] 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 I and II, nonload bearing**] [**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 (3 to 6 mm)**.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- 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. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2. Color: **[As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>**.
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing **3/8-inch (9.5-mm)** sieve and 85 percent retained on a **No. 8 (2.36-mm)** sieve.

## 2.8 STAMPED DETECTABLE WARNING MATERIALS

- A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Size of Stamp: One piece, **[matching detectable warning area shown on Drawings] [24 by 24 inches (610 by 610 mm)] [24 by 36 inches (610 by 914 mm)] [24 by 48 inches (610 by 1220 mm)] [26 by 26 inches (660 by 660 mm)] [26 by 36 inches (660 by 914 mm)] <Insert dimensions>**.
- B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to **ACI 301 (ACI 301M)**, 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:**[ Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.][ 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: **[5-1/2] [4-1/2] [2-1/2]** percent plus or minus 1-1/2 percent for **1-1/2-inch (38-mm)** nominal maximum aggregate size.

2. Air Content: [6] [4-1/2] [3] percent plus or minus 1-1/2 percent for 1-inch (25-mm) nominal maximum aggregate size.
  3. Air Content: [6] [5] [3-1/2] percent plus or minus 1-1/2 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] [0.30] percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use [water-reducing admixture] [high-range, water-reducing admixture] [high-range, water-reducing and retarding admixture] [plasticizing and retarding 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. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert requirement>.
- G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- H. Concrete Mixtures: Normal-weight concrete.
1. Compressive Strength (28 Days): [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength>.
  2. Maximum W/C Ratio at Point of Placement: [0.45] [0.50] <Insert ratio>.
  3. Slump Limit: [4 inches (100 mm)] [5 inches (125 mm)] [8 inches (200 mm)] <Insert dimension>, plus or minus 1 inch (25 mm).
  4. <Double click to insert sustainable design text for solar reflectance.>

## 2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M [and ASTM C1116/C1116M]. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), 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. (0.76 cu. m) 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. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).

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

### 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below [**concrete paving**] <Insert locations> to identify soft pockets and areas of excess yielding.
  1. Completely proof-roll subbase in one direction[ **and repeat in perpendicular direction**]. Limit vehicle speed to **3 mph (5 km/h)**.
  2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.
  3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [**1/2 inch (13 mm)**] <Insert dimension> according to requirements in Section 312000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

### 3.3 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.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- 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 (50-mm)** overlap of adjacent mats.

### 3.5 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**] [**epoxy-bonding adhesive**] 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 (38 mm)** 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 (15.25 m)**] **<Insert dimension>** unless otherwise indicated.
  - 2. Extend joint fillers full width and depth of joint.
  - 3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** 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 (6-mm)**] [**3/8-inch (10-mm)**] radius. Repeat grooving of contraction joints after applying surface finishes.[ **Eliminate grooving-tool marks on concrete surfaces.**]
    - a. Tolerance: Ensure that grooved joints are within [**3 inches (75 mm)**] <Insert dimension> 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- (3-mm-)** 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 (75 mm)**] <Insert dimension> 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 (6-mm)**] [**3/8-inch (10-mm)**] radius. Repeat tooling of edges after applying surface finishes.[ **Eliminate edging-tool marks on concrete surfaces.**]
- 3.6 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. Do not place concrete on frozen surfaces.
  - 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 (ACI 301M)** 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 (ACI 301M)** 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**] [**dowels**] [**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.

### 3.7 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 (1.6 to 3 mm)** deep with a stiff-bristled broom, perpendicular to line of traffic.

### 3.8 SPECIAL FINISHES

- A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
  2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
  3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
  4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of **1/16 inch (1.6 mm)**.
1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
  2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
  3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
  4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
1. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**] [**40 lb/100 sq. ft. (19.5 kg/10 sq. m)**] [**60 lb/100 sq. ft. (29 kg/10 sq. m)**] <Insert rate of application> of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
  2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
  3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
  4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.
- D. Rock-Salt Finish: After initial [**floating**] [**troweling**] [**brooming**], uniformly spread rock salt over paving surface at the rate of **5 lb/100 sq. ft. (0.2 kg/10 sq. m)**.
1. Embed rock salt into plastic concrete with [**roller**] [**or**] [**magnesium float**] <Insert tool>.
  2. Cover paving surface with **1-mil- (0.025-mm-)** thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.

3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.
- E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
1. Uniformly spread dry-shake hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**] **<Insert rate of application>** unless greater amount is recommended by manufacturer to match paving color required.
  2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
  3. After final power floating, apply a hand-troweled finish followed by a broom finish.
  4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

### 3.9 DETECTABLE WARNING INSTALLATION

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."
1. Tolerance for Opening Size: [**Plus 1/4 inch (6 mm), no minus**] **<Insert requirement>**.
- B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.
- C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
1. Before using stamp mats, verify that the vent holes are unobstructed.
  2. Apply liquid release agent to the concrete surface and the stamp mat.
  3. Stamping: [**While initially finished concrete is plastic**] [**After application and final floating of pigmented mineral dry-shake hardener**], accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
  4. Trimming: After [**24**] **<Insert number>** hours, cut off the tips of mortar formed by the vent holes.
  5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

### 3.10 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 (1 kg/sq. m 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 [**moisture curing**] [**moisture-retaining-cover curing**] [**curing compound**] [**or**] [**a combination of these**] as follows:
  - 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 (300-mm)** lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
  - 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.

### 3.11 PAVING TOLERANCES

- A. Comply with tolerances in **ACI 117 (ACI 117M)** and as follows:
  - 1. Elevation: **3/4 inch (19 mm)**.
  - 2. Thickness: Plus **3/8 inch (10 mm)**, minus **1/4 inch (6 mm)**.
  - 3. Surface: Gap below **10-feet- (3-m-)** long; unlevelled straightedge not to exceed **1/2 inch (13 mm)**.
  - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: **1/2 inch per 12 inches (13 mm per 300 mm)** of tie bar.
  - 5. Lateral Alignment and Spacing of Dowels: **1 inch (25 mm)**.
  - 6. Vertical Alignment of Dowels: **1/4 inch (6 mm)**.
  - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: **1/4 inch per 12 inches (6 mm per 300 mm)** of dowel.

8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

### 3.12 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [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 shall be performed according to the following requirements:
  1. Testing Frequency: Obtain at least one composite sample for each [100 cu. yd. (76 cu. m)] [5000 sq. ft. (465 sq. m)] 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 shall 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 (4.4 deg C) and below and when it is 80 deg F (27 deg C) 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 shall 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 (3.4 MPa).
- D. Test results shall be reported in writing to Architect, 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 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 Architect but will not be used as sole basis for approval or rejection of concrete.

- F. 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 Architect.
- 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.

### 3.13 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 Architect.
- B. Drill test cores, where directed by Architect, 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.

END OF SECTION 321313

## SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

## A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Cold-applied, fuel-resistant joint sealants.
4. Hot-applied, fuel-resistant joint sealants.
5. Joint-sealant backer materials.
6. Primers.

## B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

## 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** **<Insert location>**.

## 1.4 ACTION SUBMITTALS

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

- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. 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.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Installer]** **[testing agency]**.
- B. Product Certificates: For each type of joint sealant and accessory.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

## 1.7 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 F (5 deg C)**].
  - 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

### 2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing 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.

## 2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I or Type II.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- C. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I, II, or III.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- D. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type IV.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.4 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

- A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
  - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

- 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.5 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

- A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D7116, Type I or Type II.

- 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D7116, Type III.

- 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.6 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.

## 2.7 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 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.

### 3.3 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 backings 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 backings.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
  - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing 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 according to 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.

### 3.4 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.

### 3.5 PAVING-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within concrete paving[ <PJS-#>].
  - 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 sealant**] [**Single-component, self-leveling, silicone joint sealant**] [**Multicomponent, nonsag, urethane, elastomeric joint sealant**] [**Single component, pourable, urethane, elastomeric joint sealant**] [**Multicomponent, pourable, urethane, elastomeric joint sealant**] [**Hot-applied, single-component joint sealant**] <Insert joint sealant>.
  - 3. Joint-Sealant Color: [**Manufacturer's standard**] <Insert color>.
- B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving[ <PJS-#>].
  - 1. Joint Location:
    - a. Joints between concrete and asphalt paving.
    - b. Joints between concrete curbs and asphalt paving.
    - c. Other joints as indicated.
  - 2. Joint Sealant: [**Hot-applied, single-component joint sealant**] <Insert joint sealant>.
  - 3. Joint-Sealant Color: [**Manufacturer's standard**] <Insert color>.
- C. Joint-Sealant Application: Fuel-resistant joints within concrete paving[ <PJS-#>].
  - 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: [**Fuel-resistant, single-component, pourable, modified-urethane, elastomeric joint sealant**] [**Fuel-resistant, multicomponent, pourable, modified-urethane, elastomeric joint sealant**] [**Hot-applied, fuel-resistant, single-component joint sealant**] <Insert joint sealant>.
- 3. Joint-Sealant Color: [**Manufacturer's standard**] <Insert color>.

END OF SECTION 321373

## SECTION 321443 - POROUS UNIT PAVING

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:

1. Concrete grid pavers [**with aggregate fill**] [**with soil fill planted with grass seed**] [**for planting with ground cover plants**].
2. Solid concrete pavers with openings between pavers filled with aggregate.
3. Aggregate setting bed for pavers.
4. Edge restraints.
5. Precast concrete curbs.
6. Granite curbs.

- B. Related Requirements:

1. Section 312000 "Earth Moving" for excavation and compacted subgrade.
2. Section 321313 "Concrete Paving" for cast-in-place concrete curbs that serve as edge restraints for porous paving.
3. Section 321400 "Unit Paving" for nonporous unit paving, [**edge restraints**] [**precast concrete curbs**] [**and**] [**granite curbs**].
4. Section 329300 "Plants" for planting ground cover in porous paving.

## 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [**Project site**] **<Insert location>**.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For materials other than aggregates.
- B. Product Data: For the following:
  - 1. Pavers.
  - 2. Edge restraints.
  - 3. Precast concrete curbs.
  - 4. Granite curbs.
  - 5. Geotextiles.
- C. Sustainable Design Submittals:
  - 1. [<Double click to insert sustainable design text for regional materials.>](#)
- D. Sieve Analyses: For aggregate materials, according to ASTM C136.
- E. Samples:
  - 1. Full-size units of each type of unit paver indicated.
  - 2. Exposed edge restraints.
  - 3. Precast concrete curbs.
  - 4. Granite curbs.
  - 5. Aggregate fill.
  - 6. Aggregate setting bed materials.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
  - 1. For grid paving units, include durability test data based on testing according to proven field performance requirements of ASTM C1319 performed on units subjected to three years' exposure to same general type of environment, temperature range, and traffic volume as Project.
  - 2. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

#### 1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

## PART 2 - PRODUCTS

### 2.1 CONCRETE UNIT PAVERS

- A. [<Double click to insert sustainable design text for regional materials.>](#)
- B. Source Limitations: Obtain each type of paver from single source that has resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Concrete Grid Pavers: Grid paving units complying with ASTM C1319, made from normal-weight aggregates.
  1. Thickness: [**3-1/8 inches (80 mm)**] [**3-1/2 inches (90 mm)**] [**4 inches (100 mm)**] <Insert dimension>.
  2. Face Size and Shape: [As indicated] <Insert size and shape>.
  3. Opening Percentage: <Insert number>percent.
  4. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- D. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C936/C936M[, **resistant to freezing and thawing when tested according to ASTM C67**], and made from normal-weight aggregates.
  1. Thickness: [**2-3/8 inches (60 mm)**] [**3-1/8 inches (80 mm)**] [**3-1/2 inches (90 mm)**] [**4 inches (100 mm)**] <Insert dimension>.
  2. Face Size and Shape: [As indicated] <Insert size and shape>.
  3. Opening Percentage: <Insert number>percent.
  4. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

### 2.2 ACCESSORIES

- A. Plastic Edge Restraints: Triangular PVC extrusions, [**1-3/4 inches (45 mm) high by 3-1/2 inches (90 mm) wide**] [**3-1/8 inches (80 mm) high by 9-1/2 inches (240 mm) wide**], designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges, with pipe connectors and **3/8-inch- (9.5-mm-)** diameter by **12-inch- (300-mm-)** long steel spikes.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- B. Steel Edge Restraints: Painted steel edging, [**3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**] [**1/4 inch (6.4 mm) thick by 5 inches (125 mm) high**], with loops pressed from or welded to face to receive stakes at **36 inches (900 mm) o.c.**, and with steel stakes **15 inches (380 mm)** long for each loop.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- C. Aluminum Edge Restraints: [Straight, **1/8 inch (3.2 mm) thick by 4 inches (100 mm) high**] [Straight, **3/16 inch (4.8 mm) thick by 4 inches (100 mm) high**] [L-shaped, **1/8 inch (3.2 mm) thick by 1-3/8 inches (35 mm) high**] [L-shaped, **3/16 inch (4.8 mm) thick by 2-1/4 inches (57 mm) high**] extruded-aluminum edging, with loops pressed from face to receive stakes at **12 inches (300 mm) o.c.**, and with aluminum stakes **12 inches (300 mm)** long for each loop.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- D. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than [**5000 psi (35 MPa)**] [**6000 psi (41 MPa)**] <Insert compressive strength> and water absorption not more than 5 percent, in shapes and sizes indicated.
1. [<Double click to insert sustainable design text for concrete curbs.>](#)
  2. Color and Texture: [Match Architect's sample] [Match pavers] [As selected by Architect from manufacturer's full range] <Insert color and texture>.
- E. Granite Curbs: Granite curbing, with face battered **1 inch per foot (1:12)**, produced in random lengths not less than **36 inches (900 mm)** from granite complying with ASTM C615/C615M.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. [<Double click to insert sustainable design text for stone.>](#)
  3. Granite Color and Grain: [Light gray] [Dark gray] [Buff] [White] [Black] [Pink] <Insert color> with [fine] [medium] [coarse] grain.
  4. Granite Color and Grain: Match Architect's sample.
  5. Top Width: [**4 inches (100 mm)**] [**5 inches (125 mm)**] [**6 inches (150 mm)**] <Insert width>.
  6. Face Height: [**4 inches (100 mm)**] [**6 inches (150 mm)**] [**8 inches (200 mm)**] <Insert height>.
  7. Total Height: [**12 inches (300 mm)**] [**16 inches (400 mm)**] [**18 inches (450 mm)**] <Insert height>.
  8. Top Finish: [Sawn] [Thermal] [Bushhammered] <Insert finish>.
  9. Face Finish: [Split] [Sawn] [Thermal] [Bushhammered] <Insert finish>.

## 2.3 AGGREGATE SETTING-BED MATERIALS

- A. [<Double click to insert sustainable design text for aggregate and soil.>](#)

- B. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with [ASTM D448 for Size No. 57] [ASTM D448 for Size No. 5] [ASTM D2940/D2940M, subbase material] [requirements in Section 312000 "Earth Moving" for subbase material].
- C. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with [ASTM D448 for Size No. 8] [ASTM D448 for Size No. 57] [ASTM D2940/D2940M, base-course material] [requirements in Section 312000 "Earth Moving" for base-course material].
- D. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- E. Soil Mix for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate blended with planting soil <Insert drawing designation> according to [Section 329113 "Soil Preparation."] [Section 329115 "Soil Preparation (Performance Specification)."] Use blend consisting of [1/2 sand and 1/2 planting soil mix] [2/3 sand and 1/3 planting soil mix] <Insert proportions>.
- F. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D448 for Size No. [8] [9].
- G. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D4751.
  - 3. Permittivity: 0.02 per second, minimum; ASTM D4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.
- H. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D4751.
  - 3. Permittivity: 0.5 per second, minimum; ASTM D4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

## 2.4 FILL MATERIALS

- A. Soil Fill for Porous Paving: Planting soil <Insert drawing designation> according to [Section 329113 "Soil Preparation."] [Section 329115 "Soil Preparation (Performance Specification)."]
- B. Aggregate Fill for Porous Paving: Graded, sound, crushed stone or gravel complying with ASTM D448 for Size No. [8] [9].

1. Color: [**As indicated**] [**Match Architect's sample**].
- C. Grass Seed: Comply with requirements in Section 329200 "Turf and Grasses."

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive [**subbase and**] base course for porous paving.

### 3.2 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment[ **or a block splitter**] to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Tolerances:
  1. Variation in Plane between Adjacent Units (Lipping): Do not exceed **1/16-inch (1.5-mm)** unit-to-unit offset from flush.
  2. Variation from Level or Indicated Slope: Do not exceed **1/8 inch in 24 inches (3 mm in 600 mm)** and **1/4 inch in 10 feet (6 mm in 3 m)** or a maximum of **1/2 inch (13 mm)**.
- E. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
  1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after porous paver installation.
  2. For metal edge restraints with top edge exposed, drive stakes at least **1 inch (25 mm)** below top edge.
- F. Provide curbs as indicated. Install curbs before placing unit pavers.
  1. Install [**precast concrete**] [**granite**] curbs on a bedding of compacted base-course material over compacted subgrade. Install curbs before placing base course for pavers. Set curbs at elevations indicated, accurately aligned, and place and compact base-course material behind curbs as indicated.
  2. Install precast concrete curbs on aggregate base course after placing and compacting base course for pavers. Set curbs with top edge **1 inch (25 mm)** below top of pavers. Anchor curbs with metal stakes driven through holes in curbs into base-course material.

3. Install precast concrete curbs on aggregate-base course after placing and compacting base course for pavers. Set curbs with top surface [**1/2 inch (13 mm)**] [**2 inches (50 mm)**] [**4 inches (100 mm)**] above top of pavers. Anchor curbs with metal stakes driven behind curbs into base-course material.

### 3.3 SETTING-BED INSTALLATION

- A. Compact subgrade uniformly to at least [**95**] <Insert number> percent of [**ASTM D698**] [**ASTM D1557**] laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place [**separation**] [**drainage**] geotextile over prepared subgrade, overlapping ends and edges at least **12 inches (300 mm)**.
- D. Place aggregate [**subbase**] [**and**] [**base**], compact by tamping with plate vibrator, and screed to depth indicated.
- E. Place aggregate [**subbase**] [**and**] [**base**], compact to [**100**] <Insert number> percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.
- F. Place drainage geotextile over compacted subbase, overlapping ends and edges at least **12 inches (300 mm)**.
- G. Place drainage geotextile over compacted base course, overlapping ends and edges at least **12 inches (300 mm)**.
- H. Place leveling course, and screed to a thickness of [**1 to 1-1/2 inches (25 to 38 mm)**] [**2 to 2-1/2 inches (50 to 64 mm)**] [**3 inches (76 mm)**] <Insert dimension>, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

### 3.4 PAVER INSTALLATION

- A. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a **1/16-inch- (1.6-mm-)** minimum and **1/8-inch- (3.2-mm-)** maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed [**3/8 inch (10 mm)**] <Insert dimension> with pieces cut to fit from full-size pavers.
  1. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
- B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a **3500- to 5000-lbf (16- to 22-kN)** compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least **36 inches (900 mm)** of uncompacted pavers adjacent to temporary edges.
  2. Before ending each day's work, compact installed concrete pavers except for **36-inch (900-mm)** width of uncompacted pavers adjacent to temporary edges (laying faces).
  3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within **36 inches (90 mm)** of laying face.
  4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- C. Place soil fill as follows, immediately after vibrating pavers into leveling course. Spread and screed soil fill level with tops of pavers. Vibrate pavers and add soil fill until porous paving is filled to about **3/4 inch (19 mm)** from top surface; remove excess soil fill if any.
1. Before ending each day's work, place soil fill in installed porous paving except for **42-inch (1067-mm)** width of unfilled paving adjacent to temporary edges (laying faces).
  2. As work progresses to perimeter of installation, place soil fill in installed paving that is adjacent to permanent edges unless it is within **42 inches (1067 mm)** of laying face.
  3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
- D. After filling pavers with soil, sow seed according to Section 329200 "Turf and Grasses," except sow seed at half the rate specified for seeding lawns. Sweep seed from surfaces of pavers into voids and water with fine spray.
1. Within 24 hours after sowing seed, spread an additional **3/16 inch (4.8 mm)** of uncompacted soil fill over seed and soak with water.
- E. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
1. Before ending each day's work, place aggregate fill in installed porous paving except for **42-inch (1067-mm)** width of unfilled paving adjacent to temporary edges (laying faces).
  2. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within **42 inches (1067 mm)** of laying face.
  3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
- F. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

### 3.5 MAINTENANCE AND PROTECTION

- A. Water newly planted grass and keep moist until grass is established. Maintain grass that is planted in paving to comply with requirements in Section 329200 "Turf and Grasses."

- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades for [60] <Insert number> days after planting.

END OF SECTION 321443

## SECTION 334200 - STORMWATER CONVEYANCE

**TIPS:**

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**Access Manufacturer-Provided, AIA MasterSpec-Based Sections:**

[<Double click here for this Section based on specific manufacturer's products set as Basis-of-Design at ProductMasterSpec.com.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
1. Ductile-iron culvert pipe and fittings.
  2. Ductile-iron, pressure pipe and fittings.
  3. Corrugated-steel pipe and fittings.
  4. Corrugated-aluminum pipe and fittings.
  5. ABS pipe and fittings.
  6. PE pipe and fittings.
  7. PVC pipe and fittings.
  8. Fiberglass sewer pipe and fittings.
  9. Concrete pipe and fittings.
  10. Non-pressure transition couplings.
  11. Pressure pipe couplings.
  12. Expansion joints and deflection fittings.
  13. Backwater valves.
  14. Cleanouts.
  15. Drains.
  16. Encasement for piping.
  17. Manholes.

18. Polymer-concrete, channel drainage systems.
19. Plastic, channel drainage systems.
20. Catch basins.
21. Stormwater inlets.
22. Stormwater detention structures.
23. Pipe outlets.
24. Dry wells.
25. Stormwater disposal systems.

### 1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

### 1.4 ACTION SUBMITTALS

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

- B. Sustainable Design Submittals:

1. [<Double click to insert sustainable design text for adhesives.>](#)

- C. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. **[Catch basins] [stormwater inlets] [and] [dry wells]**. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than **1 inch equals 50 feet (1:500)** and vertical scale of not less than **1 inch equals 5 feet (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

### 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

## 1.7 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 in accordance with manufacturer's written rigging instructions.
- D. Handle **[catch basins]** **[and]** **[stormwater inlets]** in accordance with manufacturer's written rigging instructions.

## 1.8 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:
  - 1. Notify **[Architect]** **[Construction Manager]** **[Owner]** no fewer than **[two]** **<Insert number>** days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of service without **[Architect's]** **[Construction Manager's]** **[Owner's]** written permission.

## PART 2 - PRODUCTS

### 2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain hub-and-spigot, cast-iron soil pipe and fittings from single manufacturer.
- C. Pipe and Fittings:
  - 1. Marked with CISPI collective trademark and NSF certification mark.
  - 2. Class: ASTM A74, **[Service]** **[and]** **[Extra Heavy]** class(es).
- D. Gaskets: ASTM C564, rubber.
- E. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

### 2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain hubless cast-iron soil pipe and fittings from single manufacturer.
- C. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A888 or CISPI 301.

D. CISPI, Hubless-Piping Couplings:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain CISPI, hubless-piping couplings from single manufacturer.
3. Description: Stainless-steel corrugated shield; stainless-steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
4. Standards:
  - a. ASTM C1277 and CIPSI 310 for couplings.
  - b. ASTM C564 for gaskets.

E. Heavy-Duty, Hubless-Piping Couplings:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain heavy-duty, hubless-piping couplings from single manufacturer.
3. Description: Stainless-steel shield; stainless-steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
4. Standards:
  - a. ASTM C1277 and ASTM C1540 for couplings.
  - b. ASTM C564 for rubber gaskets.

F. Cast-Iron, Hubless-Piping Couplings:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain cast-iron, hubless-piping couplings from single manufacturer.
3. Description: Two-piece, cast-iron housing; stainless-steel bolts and nuts; and rubber sleeve with integral, center pipe stop.
4. Standards:
  - a. ASTM C1277 for couplings.
  - b. ASTM A48/A48M for cast-iron castings.
  - c. ASTM C564 for gaskets.

## 2.3 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

- A. Pipe: ASTM A716, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.

## 2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.
- C. Ductile-Iron, Push-on-Joint Piping:
  - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
  - 3. Gaskets: AWWA C111/A21.11, rubber.
- D. Ductile-Iron, Mechanical-Joint Piping:
  - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
  - 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.5 CORRUGATED-STEEL PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain corrugated-steel pipe and fittings from single manufacturer.
- C. Corrugated-Steel Pipe and Fittings: ASTM A760/A760M, Type I with fittings of similar form and construction as pipe.
  - 1. Special-Joint Bands: Corrugated steel with O-ring seals.
  - 2. Standard-Joint Bands: Corrugated steel.
  - 3. Coating: [Aluminum] [Zinc].

## 2.6 CORRUGATED-ALUMINUM PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain corrugated-aluminum pipe and fittings from single manufacturer.
- C. Corrugated-Aluminum Pipe and Fittings: ASTM B745/B745M, Type I with fittings of similar form and construction as pipe.
  - 1. Special-Joint Bands: Corrugated aluminum with O-ring seals.
  - 2. Standard-Joint Bands: Corrugated aluminum.

## 2.7 ABS PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.
- C. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- D. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.
- E. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.
- F. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
- G. Gaskets: ASTM F477, elastomeric seals.
- H. Solvent Cement: ASTM D2235.
  - 1. [<Double click to insert sustainable design text for solvent cement.>](#)
  - 2. [<Double click to insert sustainable design text for solvent cement.>](#)

## 2.8 CORRUGATED-PE PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.
- C. Corrugated-PE Drainage Pipe and Fittings **NPS 3 to NPS 10 (DN 80 to DN 250)**: AASHTO M 252, Type S, with smooth waterway for coupling joints.
- D. Corrugated-PE Pipe and Fittings **NPS 12 to NPS 60 (DN 300 to DN 1500)**: AASHTO M 294, Type S, with smooth waterway for coupling joints.
- E. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
- F. Corrugated-PE Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings.

## 2.9 PVC PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.
- C. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

## D. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, [SDR 35] <Insert SDR>, PVC socket-type fittings.

## E. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

## F. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

## G. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, [SDR 35] <Insert SDR>, 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.

## H. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, [T-1] [T-2] wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

## I. PVC Pressure Piping:

1. Pipe: AWWA C900, [Class 100] [Class 150] [and] [Class 200] PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, [Class 100] [Class 150] [and] [Class 200] PVC pipe with bell ends
3. Gaskets: ASTM F477, elastomeric seals.

## J. PVC Water-Service Piping:

1. Pipe: ASTM D1785, [Schedule 40] [and] [Schedule 80] PVC, with plain ends for solvent-cemented joints.
2. Fittings: [ASTM D2466, Schedule 40] [and] [ASTM D2467, Schedule 80] PVC, socket type.

## K. Adhesive Primer: ASTM F656.

1. <Double click to insert sustainable design text for adhesive primer.>
2. <Double click to insert sustainable design text for adhesive primer.>

## 2.10 FIBERGLASS SEWER PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.
- C. Fiberglass Sewer Pipe: ASTM D3262, RTRP for gasketed joints fabricated with [Type 2, polyester] [Type 4, epoxy] [Type 2, polyester or Type 4, epoxy] resin.
1. Liner: [Reinforced thermoset] [Nonreinforced thermoset] [Thermoplastic] [No liner].
  2. Grade: [Reinforced, surface layer matching pipe resin] [Nonreinforced, surface layer matching pipe resin] [No surface layer] <Insert grade>.
  3. Stiffness: [9 psig (62 kPa)] [18 psig (124 kPa)] [36 psig (248 kPa)] [72 psig (496 kPa)].
- D. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF for gasketed joints.
1. Laminating Resin: [Type 1, polyester] [Type 2, epoxy] [Type 1, polyester or Type 2, epoxy] resin.
  2. Reinforcement: Grade with finish compatible with resin.
- E. Gaskets: ASTM F477, elastomeric seals.

## 2.11 CONCRETE PIPE AND FITTINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.
- C. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C14 (ASTM C14M), [Class 1] [Class 2] [Class 3], with [bell-and-spigot] [or] [tongue-and-groove] ends and [gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets] [sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant].
- D. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C76 (ASTM C76M).
1. [Bell-and-spigot] [or] [tongue-and-groove] ends and [gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets] [sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant]
  2. Class I, Wall [A] [B].
  3. Class II, Wall [A] [B] [C].
  4. Class III, Wall [A] [B] [C].
  5. Class IV, Wall [A] [B] [C].
  6. Class V, Wall [B] [C].

## 2.12 NONPRESSURE 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 corrosion-resistant-metal tension band and tightening mechanism on each end.

## B. Sleeve Materials:

1. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
2. For Cast-Iron Soil Pipes: ASTM C564, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

## C. Unshielded, Flexible Couplings:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.
3. 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. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
3. 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. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
3. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

## 2.13 PRESSURE PIPE COUPLINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Source Limitations: Obtain pressure pipe couplings from single manufacturer.
- C. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.
- D. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include [**150- (1035-)**] [**200- (1380-)**] **<Insert number>** **psig (kPa)** minimum pressure rating and ends sized to fit adjoining pipes.
- E. Center-Sleeve Material: [**Manufacturer's standard**] [**Carbon steel**] [**Stainless steel**] [**Ductile iron**] [**Malleable iron**].
- F. Gasket Material: Natural or synthetic rubber.
- G. Metal Component Finish: Corrosion-resistant coating or material.

## 2.14 EXPANSION JOINTS AND DEFLECTION FITTINGS

### A. Ductile-Iron, Flexible Expansion Joints:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
3. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for **250-psig (1725-kPa)** minimum working pressure and for offset and expansion indicated.

### B. Ductile-Iron Expansion Joints:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain ductile-iron expansion joints from single manufacturer.
3. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile iron [**or**] [**steel with protective coating**]; bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53.
4. Pressure Rating: **250-psig (1725-kPa)** minimum working pressure and for expansion indicated.

### C. Ductile-Iron Deflection Fittings:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
3. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include AWWA C111/A21.11, ductile-iron glands, rubber gaskets, and steel bolts. Include AWWA C111/A21.11 ductile-iron glands, rubber gaskets, and steel bolts.
4. Pressure Rating: **250 psig (1725 kPa)** minimum.

## 2.15 BACKWATER VALVES

### A. Cast-Iron Backwater Valves:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain cast-iron backwater valves from single manufacturer.
3. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
4. Horizontal type; with swing check valve and hub-and-spigot ends.
5. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
6. Terminal type; with bronze seat, swing check valve, and hub inlet.

### B. PVC Backwater Valves:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain PVC backwater valves from single manufacturer.

3. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

## 2.16 CLEANOUTS

### A. Cast-Iron Cleanouts:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain cast-iron cleanouts from single manufacturer.
3. 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 caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
4. Top-Loading Classification(s): [**Light Duty**] [**Medium Duty**] [**Heavy Duty**] [**and**] [**Extra-Heavy Duty**].
5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

### B. PVC Cleanouts:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain PVC cleanouts from single manufacturer.
3. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

## 2.17 DRAINS

### A. Cast-Iron Area Drains:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain cast-iron area drains from single manufacturer.
3. Description: ASME A112.6.3 gray-iron round body with anchor flange and round[ **secured**] grate. Include bottom outlet with inside caulk or spigot connection, of sizes indicated.
4. Top-Loading Classification(s): [**Medium Duty**] [**and**] [**Heavy Duty**].

### B. Cast-Iron Trench Drains:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain cast-iron trench drains from single manufacturer.
3. Description: ASME A112.6.3, **6-inch- (150-mm-)** wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular[ **secured**] grate. Include units of total length indicated and quantity of bottom outlets with inside caulk or spigot connections, of sizes indicated.
4. Top-Loading Classification(s): [**Medium Duty**] [**Heavy Duty**] [**and**] [**Extra-Heavy Duty**].

### C. Steel Trench Drains:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2. Source Limitations: Obtain steel trench drains from single manufacturer.
  3. Description: Factory fabricated from ASTM A242/A242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
  4. Plate Thicknesses: [**1/8 inch (3.2 mm)**] [**and**] [**1/4 inch (6.4 mm)**].
  5. Overall Widths: [**7-1/2 inches (190 mm)**] [**and**] [**12-1/3 inches (313 mm)**].
- D. Grate Openings: [**1/4 inch (6.4 mm) circular**] [**3/8 inch (9.5 mm) circular**] [**3/8 inch (9.5 mm) circular or 3/8-by-3-inch (9.5-by-76-mm) slots**] [**3/8-by-3-inch (9.5-by-76-mm) slots**].

## 2.18 ENCASUREMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Material: [**Linear low-density polyethylene film of 0.008-inch (0.20-mm)**] [**or**] [**cross-laminated HDPE film of 0.004-inch (0.10-mm)**] minimum thickness.
- C. Form: [**Sheet**] [**or**] [**tube**].
- D. Color: [**Black**] [**or**] [**natural**] <Insert color>.

## 2.19 MANHOLES

- A. Standard Precast Concrete Manholes:
  1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  2. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
  3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
  4. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
  5. Riser Sections: **4-inch (102-mm)** minimum thickness, and lengths to provide depth indicated.
  6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
  7. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
  8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
  9. Steps: [**Individual FRP steps or FRP ladder**] [**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] [**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] <Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals.

Omit steps if total depth from floor of manhole to finished grade is less than [**60 (1500)**] **<Insert dimension> inches (mm)**.

10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Description: ASTM C913; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
3. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
4. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
5. Steps: [**Individual FRP steps or FRP ladder**] [**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] [**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] **<Insert material>**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 (1500)**] **<Insert dimension>inches (mm)**.
6. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain fiberglass manholes from single manufacturer.
3. Description: ASTM D3753.
4. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
5. Ballast: Increase thickness of concrete base as required to prevent flotation.
6. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
7. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 (1500)**] **<Insert dimension>inches (mm)**.

9. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

D. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: [ASTM A536, Grade 60-40-18 ductile] [ASTM A48/A48M, Class 35 gray] iron unless otherwise indicated.

2.20 CONCRETE

- A. General: Cast-in-place concrete in accordance with ACI 318 (ACI 318M), ACI 350 (ACI 350M), 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 (27.6 MPa) 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 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - a. Invert Slope: [1] [2] percent through manhole.
  2. Benches: Concrete, sloped to drain into channel.
    - a. Slope: [4] [8] percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

## 2.21 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

### A. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems <Insert drawing designation if any>:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain narrow, sloped-invert channel drainage systems from single manufacturer.
3. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
4. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.
  - a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
  - b. Include extension sections necessary for required depth.
  - c. Dimensions: **4-inch (102-mm)** inside width. Include number of units required to form total lengths indicated.
  - d. Frame: [**Gray-iron or galvanized steel for grates**] [**Not required**].
5. Grates: Manufacturer's designation "[**heavy**] [**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
  - a. Material: [**Ductile iron**] [**Fiberglass**] [**Galvanized steel**] [**Gray iron**] [**Stainless steel**] <Insert material>.
    - 1) Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**] [**Not required**].
6. Covers: Solid [**ductile or gray iron**] <Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

### B. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems <Insert drawing designation if any>:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain narrow, level-invert channel drainage systems from single manufacturer.
3. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
4. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

- a. Include rounded bottom, with level invert and with **NPS 4 (DN 100)** outlets in number and locations indicated.
  - b. Dimensions: [**5- (127-)**] **<Insert dimension> inch (mm)** inside width and [**9-3/4 (248)**] **<Insert dimension> inches (mm)** deep. Include number of units required to form total lengths indicated.
    - 1) Frame: [**Gray-iron or galvanized steel for grates**] [**Not required**].
5. Grates: Manufacturer's designation "[**heavy**] [**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
- a. Material: [**Ductile iron**] [**Fiberglass**] [**Galvanized steel**] [**Gray iron**] [**Stainless steel**] **<Insert material>**.
  - b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**] [**Not required**].
6. Covers: Solid [**ductile or gray iron**] **<Insert material>**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems **<Insert drawing designation if any>**:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Source Limitations: Obtain wide, level-invert channel drainage systems from single manufacturer.
  3. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
  4. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.
    - a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
    - b. Dimensions: [**8- (203-)**] **<Insert dimension> inch (mm)** inside width and [**13-3/4 (350)**] **<Insert dimension> inches (mm)** deep. Include number of units required to form total lengths indicated.
      - 1) Frame: [**Gray iron or galvanized steel for grates**] [**Not required**].
5. Grates: Manufacturer's designation "[**heavy**] [**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
- a. Material: [**Ductile iron**] [**Fiberglass**] [**Galvanized steel**] [**Gray iron**] [**Stainless steel**] **<Insert material>**.
  - b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**] [**Not required**].

6. Covers: Solid [**ductile or gray iron**] <Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

D. Drainage Specialties: Precast, polymer-concrete units.

1. Large Catch Basins:
  - a. **24-by-12-inch (610-by-305-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
  - b. Gray-iron slotted grate.
  - c. Frame: Include gray-iron or steel frame for grate.
2. Small Catch Basins:
  - a. **19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
  - b. Gray-iron slotted grate.
  - c. Frame: Include gray-iron or steel frame for grate.
3. Oil Interceptors:
  - a. Polymer-concrete body with interior baffle and four steel support channels and two **1/4-inch- (6.4-mm-)** thick, steel-plate covers.
  - b. Capacity: [**140 gal. (530 L)**] [**200 gal. (757 L)**] [**260 gal. (984 L)**].
  - c. Inlet and Outlet: [**NPS 4 (DN 100)**] [**NPS 6 (DN 150)**].
4. Sediment Interceptors:
  - a. **27-inch- (686-mm-)** square, polymer-concrete body, with outlets in quantities and sizes indicated.
  - b. **24-inch- (610-mm-)** square, gray-iron frame and slotted grate.

## 2.22 PLASTIC, CHANNEL DRAINAGE SYSTEMS

A. General Requirements for Plastic, Channel Drainage Systems:

1. Modular system of plastic channel sections, grates, and appurtenances.
2. Designed so grates fit into frames without rocking or rattling.
3. Number of units required to form total lengths indicated.

B. FRP Channel Drainage Systems <Insert drawing designation if any>:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain FRP channel drainage systems from single manufacturer.
3. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

4. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.
    - a. Dimensions: **[4 inches (102 mm)] [4 or 6 inches (102 or 152 mm)] [6 inches (152 mm)] [6 or 8 inches (152 or 203 mm)] [8 inches (203 mm)]** wide. Include number of units required to form total lengths indicated.
    - b. Frame: **[Galvanized steel] [Stainless steel] [Manufacturer's standard metal] <Insert material>** for grates.
  5. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
    - a. Material: **[Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>**.
    - b. Locking Mechanism: **[Manufacturer's standard device for securing grates to channel sections] [Not required]**.
  6. Covers: Solid **[ductile or gray iron] <Insert material>**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
  7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
  8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. HDPE or PE Channel Drainage Systems **<Insert drawing designation if any>**:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Source Limitations: Obtain HDPE or PE channel drainage systems from single manufacturer.
  3. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
  4. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.
    - a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.
  5. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
    - a. Material: **[Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>**.
    - b. Color: **<Insert color or delete subparagraph>**.
  6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
  7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

## 2.23 CATCH BASINS

## A. Standard Precast Concrete Catch Basins:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: **4-inch (102-mm)** minimum thickness, **48-inch (1200-mm)** diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
8. Steps: [**Individual FRP steps or FRP ladder**] [**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] [**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] <Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 (1500)**] <Insert dimension>**inches (mm)**.
9. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

## B. Designed Precast Concrete Catch Basins: ASTM C913, precast, reinforced concrete; designed in accordance with ASTM C890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
4. Steps: [**Individual FRP steps or FRP ladder**] [**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] [**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] <Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 (1500)**] <Insert dimension>**inches (mm)**.
5. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

- C. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: **24 by 24 inches (610 by 610 mm)** minimum unless otherwise indicated.
  2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
- D. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (102-mm-)** minimum width flange, and **26-inch- (660-mm-)** diameter flat grate with small square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

## 2.24 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening[, **of materials and dimensions in accordance with utility standards**].
- B. Gutter Inlets: Made with horizontal gutter opening[, **of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.
- C. Combination Inlets: Made with vertical curb and horizontal gutter openings[, **of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.
- D. Frames and Grates: Heavy duty[, **in accordance with utility standards**].

## 2.25 STORMWATER DETENTION STRUCTURES

- A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
1. Ballast: Increase thickness of concrete as required to prevent flotation.
  2. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 229-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and cover.
  3. Steps: [**Individual FRP steps or FRP ladder**] [**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] [**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**] <Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of structure to finished grade is less than [**60 (1500)**] <Insert dimension>**inches (mm)**.
- B. Manhole Frames and Covers: ASTM A536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (102-mm-)** minimum width flange, and **26-inch- (660-mm-)** diameter cover. Include

indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

## 2.26 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregularly sized and shaped, graded stone in accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control."
  - 1. Average Size: NSSGA No. R-3, screen opening **2 inches (51 mm)**.
  - 2. Average Size: NSSGA No. R-4, screen opening **3 inches (76 mm)**.
  - 3. Average Size: NSSGA No. R-5, screen opening **5 inches (127 mm)**.
- C. Filter Stone: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
- D. Energy Dissipaters: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, **3-ton (2721-kg)** average weight armor stone, unless otherwise indicated.

## 2.27 DRY WELLS

- A. Description: ASTM C913, precast, reinforced, perforated concrete rings. Include the following:
  - 1. Floor: Cast-in-place concrete.
  - 2. Cover: Liftoff-type concrete cover with cast-in lift rings.
  - 3. Wall Thickness: **4 inches (102 mm)** minimum with **1-inch (25-mm)** diameter or **1-by-3-inch- (25-by-76-mm-)** maximum slotted perforations arranged in rows parallel to axis of ring.
    - a. Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
    - b. Ring Construction: Designed to be self-aligning.
  - 4. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
- B. Manufactured PE Dry Wells:
  - 1. Description: Manufactured PE side panels and top cover that assemble into **50-gal. (190-L)** storage capacity units.
  - 2. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  - 3. Source Limitations: Obtain manufactured PE dry wells from single manufacturer.
  - 4. Side Panels: With knockout ports for piping and seepage holes.
  - 5. Top Cover: With knockout port for drain.
  - 6. Filter Fabric: As recommended by unit manufacturer.
  - 7. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
- C. Description: Constructed-in-place aggregate type. Include the following:

1. Lining: Clay or concrete bricks.
2. Lining: Concrete blocks or precast concrete rings with notches or weep holes.
3. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
4. Cover: Precast, reinforced-concrete slab, designed for structural loading in accordance with ASTM C890 and made in accordance with ASTM C913. Include slab dimensions that will extend **12 inches (300 mm)** minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
5. Manhole: **24-inch- (610-mm-)** diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

## 2.28 STORMWATER DISPOSAL SYSTEMS

### A. Chamber Systems:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain chamber systems from single manufacturer.
3. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
4. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
5. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of **4 oz./sq. yd. (135 g/sq. m).**

### B. Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252 for **NPS 10 (DN 250)** and smaller, AASHTO M 294 for **NPS 12 to NPS 60 (DN 300 to DN 1500)**. Include proprietary fittings, couplings, seals, and filter fabric.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Source Limitations: Obtain pipe systems from single manufacturer.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage 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 in accordance with manufacturer's written instructions for use of 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure drainage piping in accordance with the following:
  - 1. Install piping pitched down in direction of flow.
  - 2. Install piping [**NPS 6 (DN 150)**] <Insert value> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
  - 3. Install piping with [**36- (915-)**] [**48- (1220-)**] [**60- (1520-)**] [**72- (1830-)**] <Insert dimension> inch- (mm-) minimum cover.
  - 4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 6. Install ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
  - 7. Install corrugated-steel piping in accordance with ASTM A798/A798M.
  - 8. Install corrugated-aluminum piping in accordance with ASTM B788/B788M.
  - 9. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
  - 10. Install PE corrugated sewer piping in accordance with ASTM D2321.
  - 11. Install PVC cellular-core piping in accordance with ASTM D2321 and ASTM F1668.
  - 12. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
  - 13. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
  - 14. Install PVC water-service piping in accordance with ASTM D2321 and ASTM F1668.
  - 15. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
  - 16. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
  - 17. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
- G. Install force-main pressure piping in accordance with the following:
  - 1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
  - 2. Install piping with [**36- (915-)**] [**48- (1220-)**] [**60- (1520-)**] [**72- (1830-)**] <Insert dimension> inch- (mm-) minimum cover.
  - 3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
  - 4. Install ductile-iron special fittings in accordance with AWWA C600.

5. Install PVC pressure piping in accordance with AWWA M23, or ASTM D2774 and ASTM F1668.
  6. Install PVC water-service piping in accordance with ASTM D2774 and ASTM F1668.
- H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:
1. Hub-and-spigot, cast-iron soil pipe and fittings.
  2. Hubless cast-iron soil pipe and fittings.
  3. Ductile-iron pipe and fittings.
  4. Expansion joints and deflection fittings.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping in accordance with the following:
1. Join hub-and-spigot, cast-iron soil piping with gasketed joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
  3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
  4. Join ductile-iron culvert piping in accordance with AWWA C600 for push-on joints.
  5. Join ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
  6. Join corrugated-steel sewer piping in accordance with ASTM A798/A798M.
  7. Join corrugated-aluminum sewer piping in accordance with ASTM B788/B788M.
  8. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
  9. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
  10. Join PVC cellular-core piping in accordance with ASTM D2321 and ASTM F891 for solvent-cemented joints.
  11. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
  12. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
  13. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
  14. Join fiberglass sewer piping in accordance with ASTM D3839 for elastomeric-seal joints.
  15. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
  16. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
  17. Join dissimilar pipe materials with nonpressure-type flexible couplings.
- B. Join force-main pressure piping in accordance with the following:
1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
  2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.

3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
4. Join PVC water-service piping in accordance with ASTM D2855 for solvent-cemented joints.
5. Join dissimilar pipe materials with pressure-type couplings.

### 3.4 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping where indicated.
- B. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.
- C. Install terminal-type backwater valves on end of piping and in manholes where indicated.

### 3.5 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 cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  1. Use Light-Duty, top-loading classification cleanouts in [**earth or unpaved foot-traffic**] <Insert other> areas.
  2. Use Medium-Duty, top-loading classification cleanouts in [**paved foot-traffic**] <Insert other> areas.
  3. Use Heavy-Duty, top-loading classification cleanouts in [**vehicle-traffic service**] <Insert other> areas.
  4. Use Extra-Heavy-Duty, top-loading classification cleanouts in [**roads**] <Insert area>.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, [**18 by 18 by 12 (450 by 450 by 300)**] <Insert dimensions> inches (mm) deep. Set with tops [**1 (25)**] <Insert dimension> inch(es) (mm) above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

### 3.6 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
  1. Use Light-Duty, top-loading classification drains in [**earth or unpaved foot-traffic**] <Insert other> areas.
  2. Use Medium-Duty, top-loading classification drains in [**paved foot-traffic**] <Insert other> areas.
  3. Use Heavy-Duty, top-loading classification drains in [**vehicle-traffic service**] <Insert other> areas.
  4. Use Extra-Heavy-Duty, top-loading classification drains in [**roads**] <Insert area>.
- B. Embed drains in **4-inch- (102-mm-)** minimum concrete around bottom and sides.

- C. Fasten grates to drains if indicated.
- D. Set drain frames and covers with tops flush with pavement surface.
- E. Assemble trench sections with flanged joints.
- F. Embed trench sections in [~~4-~~ (102-)] <Insert dimension> inch- (mm-) minimum concrete around bottom and sides.

### 3.7 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [3 (76)] <Insert dimension> inches (mm) above finished surface elsewhere unless otherwise indicated.

### 3.8 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

### 3.9 STORMWATER INLET[ AND OUTLET] INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

### 3.10 DRY WELL INSTALLATION

- A. Excavate hole to diameter of at least 6 inches (150 mm) greater than outside of dry well. Do not extend excavation into ground-water table.
- B. Install precast, concrete-ring dry wells in accordance with the following:
  - 1. Assemble rings to depth indicated.

2. Extend rings to height where top of cover will be approximately **8 inches (203 mm)** below finished grade.
  3. Backfill bottom of inside of rings with filtering material to level at least **12 inches (300 mm)** above bottom.
  4. Extend effluent inlet pipe **12 inches (300 mm)** into rings and terminate into side of tee fitting.
  5. Backfill around outside of rings with filtering material to top level of rings.
  6. Install cover over top of rings.
- C. Install manufactured, PE dry wells in accordance with manufacturer's written instructions and the following:
1. Assemble and install panels and cover.
  2. Backfill bottom of inside of unit with filtering material to level at least [**12 (300)**] **<Insert dimension> inches (mm)** above bottom.
  3. Extend effluent inlet pipe [**12 (300)**] **<Insert dimension> inches (mm)** into unit and terminate into side of tee fitting.
  4. Install filter fabric around outside of unit.
  5. Install filtering material around outside of unit.
- D. Install constructed-in-place dry wells in accordance with the following:
1. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
  2. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
  3. Extend lining material to height where top of manhole will be approximately [**8 (203)**] **<Insert dimension> inches (mm)** below finished grade.
  4. Backfill bottom of inside of lining with filtering material to level at least [**12 (300)**] **<Insert dimension> inches (mm)** above bottom.
  5. Extend effluent inlet pipe [**12 (300)**] **<Insert dimension> inches (mm)** into lining and terminate into side of tee fitting.
  6. Backfill around outside of lining with filtering material to top level of lining.
  7. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.
- 3.11 CONCRETE PLACEMENT
- A. Place cast-in-place concrete in accordance with **ACI 318 (ACI 318M)**.
- 3.12 CHANNEL DRAINAGE SYSTEM INSTALLATION
- A. Install with top surfaces of components, except piping, flush with finished surface.
  - B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

- C. Embed channel sections and drainage specialties in [4- (102-)] <Insert dimension> inch- (mm-) minimum concrete around bottom and sides.
- D. Fasten grates to channel sections if indicated.
- E. Assemble channel sections with flanged or interlocking joints.
- F. Embed channel sections in [4- (102-)] <Insert dimension> inch- (mm-) minimum concrete around bottom and sides.

### 3.13 STORMWATER DISPOSAL SYSTEM INSTALLATION

- A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill in accordance with chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.
- B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, in accordance with piping manufacturer's written instructions.

### 3.14 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Section 221413 "Facility Storm Drainage Piping." Terminate piping where indicated.
- C. 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 (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
    - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.

- b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."
- E. 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-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. **[Unshielded]** **[Shielded]** flexible couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible 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.
  2. Use pressure-type pipe couplings for force-main joints.

### 3.15 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
1. Close open ends of piping with at least **[8- (203-)]** **<Insert dimension>** **inch-** **(mm-)** thick, brick masonry bulkheads.
  2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
1. Remove manhole or structure and close open ends of remaining piping.
  2. Remove top of manhole or structure down to at least **[36 (915)]** **<Insert dimension>** **inches** **(mm)** below final grade. Fill to within **[12 (300)]** **<Insert dimension>** **inches** **(mm)** of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade in accordance with Section 312000 "Earth Moving."

### 3.16 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use[ **warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

### 3.17 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (610 mm)** of backfill is in place, and again at completion of Project.
1. Submit separate reports 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 in accordance with 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. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    - b. Option: Test plastic piping in accordance with ASTM F1417.
  6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than **[150 (1035)] <Insert number>** psig (kPa).
    - a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
    - b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.
- 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.

3.18 CLEANING

- A. Clean interior of piping of dirt and superfluous materials.[ **Flush with potable water.**][ **Flush with water.**]

END OF SECTION 334200

## SECTION 334600 - SUBDRAINAGE

**TIPS:**

To view non-printing **Editor's Notes** that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

**Content Requests:**

[<Double click here to submit questions, comments, or suggested edits to this Section.>](#)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Perforated-wall pipe and fittings.
  - 2. Drainage conduits.
  - 3. Drainage panels.
  - 4. Geotextile filter fabrics.

## 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. Drainage conduits, including rated capacities.
  - 2. Drainage panels, including rated capacities.
  - 3. Geotextile filter fabrics.

## PART 2 - PRODUCTS

## 2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:

1. **NPS 6 (DN 150)** and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. **NPS 8 (DN 200)** and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

## 2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cusped, molded-plastic drainage core wrapped in geotextile filter fabric.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Nominal Size: **12 inches (305 mm)** high by approximately **1 inch (25 mm)** thick.
  - a. Minimum In-Plane Flow: [**30 gpm (114 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
3. Nominal Size: **18 inches (457 mm)** high by approximately **1 inch (25 mm)** thick.
  - a. Minimum In-Plane Flow: [**45 gpm (170 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Nominal Size: **6 inches (152 mm)** high by approximately **1-1/4 inches (31 mm)** thick.
  - a. Minimum In-Plane Flow: [**15 gpm (57 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
3. Nominal Size: **12 inches (305 mm)** high by approximately **1-1/4 inches (31 mm)** thick.
  - a. Minimum In-Plane Flow: [**30 gpm (114 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
4. Nominal Size: **18 inches (457 mm)** high by approximately **1-1/4 inches (31 mm)** thick.
  - a. Minimum In-Plane Flow: [**45 gpm (170 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
5. Filter Fabric: Nonwoven, needle-punched geotextile.
6. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

7. Couplings: HDPE.
- C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Nominal Size: **12 inches (305 mm)** high by approximately **1 inch (25 mm)** thick.
    - a. Minimum In-Plane Flow: [**30 gpm (114 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
  3. Nominal Size: **18 inches (457 mm)** high by approximately **1 inch (25 mm)** thick.
    - a. Minimum In-Plane Flow: [**45 gpm (170 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
  4. Filter Fabric: PP geotextile.
  5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.
  6. Couplings: Corrugated HDPE band.
- D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Nominal Size: **6 inches (150-mm)** high by approximately **0.9 inch (23 mm)** thick.
    - a. Minimum In-Plane Flow: [**2.4 gpm (9.1 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
  3. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested according to ASTM D4491.
- E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Nominal Size: **18 inches (0.5 m)** high by **1 inch (25 mm)** thick.
    - a. Minimum In-Plane Flow: [**82 gpm (310 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
  3. Nominal Size: **36 inches (1 m)** high by **1 inch (25 mm)** thick.
    - a. Minimum In-Plane Flow: [**164 gpm (621 L/min.)**] **<Insert value>** at hydraulic gradient of [**1.0**] **<Insert value>** when tested according to ASTM D4716.
  4. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

## 2.3 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, [36 to 60 inches (915 to 1525 mm)] <Insert dimension> wide with drainage core faced with geotextile filter fabric.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
    - a. Minimum Compressive Strength: [10,000 lbf/sq. ft. (479 kPa)] [15,000 lbf/sq. ft. (718 kPa)] [18,000 lbf/sq. ft. (862 kPa)] [21,000 lbf/sq. ft. (1005 kPa)] <Insert value> when tested according to ASTM D1621.
    - b. Minimum In-Plane Flow Rate: [2.8 gpm/ft. (35 L/min. per m)] [7 gpm/ft. (87 L/min. per m)] [15 gpm/ft. (186 L/min. per m)] <Insert value> of unit width at hydraulic gradient of [1.0] <Insert value> and compressive stress of [25 psig (172 kPa)] <Insert value> when tested according to ASTM D4716.
  3. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
    - a. Survivability: [Class 1] [Class 2] [Class 3].
    - b. Apparent Opening Size: [No. 40 (0.425-mm)] [No. 60 (0.25-mm)] [No. 70 (0.212-mm)] sieve, maximum.
    - c. Permittivity: [0.5] [0.2] [0.1] per second, minimum.
  4. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:
    - a. Survivability: [Class 1] [Class 2] [Class 3].
    - b. Apparent Opening Size: [No. 40 (0.425-mm)] [No. 60 (0.25-mm)] [No. 70 (0.212-mm)] [No. 30 (0.6-mm)] sieve, maximum.
    - c. Permittivity: [0.5] [0.2] [0.1] [0.02] per second, minimum.
  5. Film Backing: Polymeric film bonded to drainage core surface.
- B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately 0.4 inches (10.2 mm) thick.
    - a. Minimum In-Plane Flow Rate: [2.4 gpm/ft. (30 L/min. per m)] <Insert value> of unit width at hydraulic gradient of [1.0] <Insert value> and normal pressure of 25 psig (172 kPa) when tested according to ASTM D4716.
  3. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D4491.

- C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately **0.25 inches (6 mm)** thick.
    - a. Minimum In-Plane Flow Rate: [**2.4 gpm/ft. (30 L/min. per m)**] [**5 gpm/ft. (62 L/min. per m)**] **<Insert value>** of unit width at hydraulic gradient of [**1.0**] **<Insert value>** and normal pressure of **25 psig (172 kPa)** when tested according to ASTM D4716.
  3. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested according to ASTM D4491.
- D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
  2. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately **1 inch (25 mm)** thick.
    - a. Minimum In-Plane Flow Rate: [**40 gpm/ft. (500 L/min. per m)**] **<Insert value>** of unit width at hydraulic gradient of [**1.0**] **<Insert value>** and normal pressure of **25 psig (172 kPa)** when tested according to ASTM D4716.

## 2.4 SOIL MATERIALS

- A. Soil materials are specified in Section 312000 "Earth Moving."

## 2.5 WATERPROOFING FELTS

- A. Material: Comply with [ASTM D226, Type I, asphalt] [or] [ASTM D227, coal-tar]-saturated organic felt.

## 2.6 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from **110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m)** when tested according to ASTM D4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
1. Survivability: AASHTO [M 288 Class 2] **<Insert class>**.
  2. Styles: Flat and sock.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

## 3.3 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than **6 inches (150 mm)** deep and **12 inches (300 mm)** wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with **[adhesive] [or] [tape]**.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of **[flat-style geotextile filter fabric] [waterproofing felt]** over top of drainage course, overlapping edges at least **4 inches (100 mm)**.
- J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.
  2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
  3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
  4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
- K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

### 3.4 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [adhesive] [or] [tape].
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.
- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
1. Coordinate placement with other drainage materials.
  2. Lay perforated drainage pipe at inside edge of footing.
  3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
  4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

### 3.5 RETAINING-WALL DRAINAGE INSTALLATION

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than **4 inches (100 mm)**.
- C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with **[adhesive] [or] [tape]**.
- D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- E. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.
- G. Place drainage course in layers not exceeding **3 inches (75 mm)** in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of **[flat-style geotextile filter fabric] [waterproofing felt]** over top of drainage course, overlapping edges at least **4 inches (100 mm)**.
- I. Install drainage panels on wall as follows:
  - 1. Coordinate placement with other drainage materials.
  - 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
  - 3. If weep holes are used instead of drainage pipe, cut **1/2-inch- (13-mm-)** diameter holes on core side at weep-hole locations. Do not cut fabric.
  - 4. Mark horizontal chalk line on wall at a point **6 inches (150 mm)** less than panel width above footing bottom. Before marking wall, subtract footing width.
  - 5. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
  - 6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from **2 to 6 inches (50 to 150 mm)** below top of panel, approximately **48 inches (1200 mm)** apart. **[ Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.]** Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
  - 7. If another panel is required on same row, cut away **4 inches (100 mm)** of installed panel core and wrap fabric over new panel.
  - 8. If additional rows of panel are required, overlap lower panel with **4 inches (100 mm)** of fabric.
  - 9. Cut panel as necessary to keep top **12 inches (300 mm)** below finish grade.
  - 10. For inside corners, bend panel. For outside corners, cut core to provide **3 inches (75 mm)** for overlap.
- J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

### 3.6 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least **6 inches (150 mm)** between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with **[adhesive] [or] [tape]**.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within **12 inches (300 mm)** of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of **[flat-style geotextile filter fabric] [waterproofing felt]** over top of drainage course, overlapping edges at least **4 inches (100 mm)**.
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

### 3.7 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - 1. Foundation Subdrainage: Install piping level and with a minimum cover of **[36 inches (915 mm)] <Insert dimension>** unless otherwise indicated.
  - 2. Underslab Subdrainage: Install piping level.
  - 3. Plaza Deck Subdrainage: Install piping level.
  - 4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of **[36 inches (915 mm)] <Insert dimension>** unless otherwise indicated.
  - 5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of **[0.5] <Insert value>** percent and with a minimum cover of **[36 inches (915 mm)] <Insert dimension>** unless otherwise indicated.
  - 6. Lay perforated pipe with perforations down.
  - 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping according to ASTM D2321.

### 3.8 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings according to ASTM D3212 with loose banded, coupled, or push-on joints.
- B. Join perforated PVC sewer pipe and fittings according to ASTM D3212 with loose bell-and-spigot, push-on joints.
- C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

### 3.9 BACKWATER VALVE INSTALLATION

- A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."
- B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
- C. Install horizontal backwater valves in piping[ **in manholes or pits**] where indicated.

### 3.10 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for [**Foundation**] [**Retaining-Wall**] [**and**] [**Landscaping**] Subdrainage:
  - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - 2. In vehicular-traffic areas, use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**18 by 18 by 12 inches (450 by 450 by 300 mm)**] <Insert **dimensions**> deep. Set top of cleanout flush with grade.
  - 3. In nonvehicular-traffic areas, use **NPS 4 (DN 100)** [**cast-iron**] [**PVC**] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**12 by 12 by 4 inches (300 by 300 by 100 mm)**] <Insert **dimensions**> deep. Set top of cleanout [**1 inch (25 mm)**] [**2 inches (50 mm)**] <Insert **dimension**> above grade.
  - 4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."
- C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

### 3.11 CONNECTIONS

- A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to[ **building's**] solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of [**foundation**] [**underslab**] subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

### 3.12 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
  1. Install PE warning tape or detectable warning tape over ferrous piping.
  2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

### 3.13 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
  2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.14 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600