CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
PROJECT NO. TMUA-W 19-09
A.B. JEWELL WATER TREATMENT PLANT SITE
MAINTENANCE AND REHABILITATION

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

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Tulsa
A New Kind of Energy™

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VOLUME 2
TULSA METROPOLITAN UTILITY AUTHORITY
TULSA, OKLAHOMA

AB JEWELL WTP SITE MAINTENANCE AND REHABILITATION

PROJECT NO. TMUA-W 19-09

TECHNICAL SPECIFICATIONS

VOLUME 2 OF 2

APRIL 2023
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SECTION 01_11_00

SUMMARY OF WORK

PART 1  GENERAL

1.01  SUMMARY

A. This project has four components:
   1. Main Entrance Modification.
   2. Truck Scale Installation.
   3. Reconstructed Intersection near the Raw Water Chemical Building.
   4. Trench Cover Replacement.

1.02  THE WORK

A. This work includes providing the materials, equipment, labor, and energy necessary to complete these improvements all while keeping full access and security to the Water Treatment Facility. This facility must always remain in full operation and with security measures in place at all times. This includes maintaining access and proper security for staff, chemical feed supplier vehicles and contractors.

B. To keep the facility in full operation the Contractor must provide temporary facilities for access and security. This work is to include temporary fencing, gates, portable guard shacks, certified security guards, electronic security measures and manpower necessary to keep the facility secure at all times when the permanent security measures are not in place.

C. All demolished materials shall be removed from the site. All materials removed and reset shall be protected from damage during construction.

D. The Truck Scale Installation involves a delegated design of the Truck Scale Pit, Sump pump Pit, Approach/Discharge pads, Truck Scale Cabinet supports and foundation, Electrical grounding, and lightning protection for the truck scale installation. The scope for this work is sufficiently well designed and defined within the contract documents to provide sufficient information for the contractor to establish the costs during bidding. As a result, no claims for changes in the contract price or contract time shall be made relating to this scope of work unless the actual design criteria and conditions are significantly different from those indicated on the drawings and specified in Section 01_35_73 – Delegated Design Procedures. The contractor must provide sufficient evidence of these changes in conditions or criteria with any claims related to the design, procurement, installation, testing, or commissioning of any or all of the delegated design components of the truck scale.

E. The plant entrance modifications involves a delegated design of the relocation of the existing prefabricated steel guard house, electrical grounding, and lighting protection systems for the entrance. The scope for this work is sufficiently well designed and defined within the contract documents to provide sufficient information for the contractor to establish the costs during bidding. As a result, no claims for changes in the contract price or contract time shall be made relating to this scope of work unless the actual design criteria and conditions are significantly different from
those indicated on the drawings and specified in Section 01_35_73 – Delegated Design Procedures. The contractor must provide sufficient evidence of these changes in conditions or criteria with any claims related to the design, procurement, installation, testing, or commissioning of any or all of the delegated design components of the plant entrance modifications.

1.03 LOCATION OF PROJECT

A. The Work is located at the A B Jewell Water Treatment Plant, 18707 E 21st St, Tulsa, OK 74134.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_29_73

SCHEDULE OF VALUES

Part 1  General

1.01 SUMMARY

A. Section includes: Requirements for preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Schedule of Values shall be a listing of all pay items as indicated on the drawings and included in the progress schedule, listed in numerical order, showing that the sum total of all pay items and associated cost-loaded activities equal the Contract value.

B. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all pay items and associated cost-loaded activities continuously equal the current Contract value.

C. Prepare Schedule of Values identifying costs of all pay items as indicated on the drawings.

1.03 SUBMITTALS

A. Submit Schedule of Values for the Preliminary Schedule as specified in, Section 01_32_21 - Schedules and Reports.

Part 2  Products (Not Used)

Part 3  Execution (Not Used)

End of Section
SECTION 01_29_77
APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for preparation and submittal of Applications for Payment.

B. Applications for Payment shall conform to the most recent version of the City of Tulsa Standard specifications.

1.02 FORMAT

A. Develop satisfactory spreadsheet-type form generated by downloading pay items as indicated on the drawings from the Progress Schedule:
   1. Submit payment requests and attach spreadsheet with pay items related to Progress Schedule.

B. Fill in information required on payment application form.

C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
   1. Identify change order by number and description.
   2. Provide cost of change order in appropriate column.

D. When amendments to pay item quantities are established:
   1. Identify amendment by number and description
   2. Provide adjusted quantities in payment application for pay items.

E. Draft Application for Payment Review: the OWNER will be providing field inspection services. CONTRACTOR shall review draft pay application with OWNER’s field inspection service to verify progress of work, stored materials, and unit quantities for each of the pay items.

F. After completing, submit Application for Payment.

G. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.

H. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

A. Provide Substantiating Data identifying:
   1. Project.
   2. Application number and date.
   3. Cost flow summary for each pay item.
   4. Updated schedule of values.
5. Progress schedule.
6. Detailed list of enclosures.
7. For stored products with item number and identification on application, description of specific material, and proof of insurance coverage for offsite stored products.
8. Submit "certified" payroll, if applicable.

1.04 SUBMITTALS

A. Submit 5 copies of Application for Payment and Substantiating Data with cover letter.

1.05 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project for each pay item. Equate sum of monthly amounts to Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.

D. Identify each activity on the Progress Schedule that associated with a pay item, the cost for each activity, the estimated percent complete for each activity, the quantity of that item, and the value of work completed for both the payment period and job to date.

E. Prepare summary of cost information for each Pay Item and associated Major Item of Work listed in the Schedule of Values. Identify the value of work, quantity completed, completed for both the payment period and job to date.

F. Payment period:
   1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
   2. Submit Application for Payment to Engineer no later than the 5th day of each month for work completed the previous month.
   3. Engineer will finalize and submit recommendation for Application for Payment to Owner by the 15th day of each month to allow time for processing and approval.

1.06 COST SUMMARIES

A. Prepare Summary of Cost Information for each pay item listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to pay items as indicated on the drawings.
PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_32_21
SCHEDULES AND REPORTS

PART 1  GENERAL

1.01 SUMMARY

A.  Section includes: Schedules and reports.

1.02 SUBMITTAL REQUIREMENTS

A.  Submit preliminary and baseline schedule.

B.  Submit preliminary and baseline schedule of values.

C.  Submit preliminary and baseline schedule of submittals.

D.  Submit, on a monthly basis, updated schedules as specified.

E.  Submit final schedule update as specified.

F.  Submit revised schedules and time impact analyses as specified.

G.  Submit schedules in the media and number of copies as follows:
   1. Provide each submittal in PDF format and in other formats specified in this Section.
   2. 3 sets of the CPM network and/or bar chart (as specified by the Owner) on D-size sheets:
      a.  Color-coding to be specified by the Owner.
   3. 3 sets of tabular reports listing all activities sorted numerically identifying duration, early start, late start, early finish, late finish, total float, and all predecessor/successor information.
   4. 2 sets of CPM Schedule data electronic files in a native backed-up file.

1.03 SCHEDULER

A.  Designate, in writing and within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.

1.04 SCHEDULING FORMAT AND SOFTWARE

A.  Schedule format: Utilize CPM format.

B.  Prepare computerized schedule utilizing Primavera P6 Professional or Owner Approved Equal software, most current version:
   1. Provide 1 licensed copy of the scheduling software to the engineer, registered in the Engineer's name, for the duration of the project.
   2. The provided copy of the software shall be a standalone version for installation on a standalone computer.
C. Contractor and Engineer must agree on the format.

1.05 PRECONSTRUCTION SCHEDULING MEETING

A. Engineer will conduct Preconstruction Scheduling Meeting with Contractor’s Project Manager, General Superintendent, and scheduler within 7 calendar days after Notice to Proceed:
   1. This meeting is separate from the Preconstruction Conference Meeting and is intended to exclusively cover schedule issues.

B. At the meeting, review scheduling requirements:
   1. These include schedule preparation, reporting requirements, labor and equipment loading, updates, revisions, and schedule delay analysis.
   2. Present schedule methodology, planned sequence of operations, cost and resource loading methodology, and proposed activity coding structure.
   3. Naming convention: Name schedule files with the year, month and day of the date, revision identifier, and a description of the schedule:
      a. Example 1: 2014_07_30 rev 1 draft baseline schedule.xer.

C. Filing: Post submitted files to Owner’s construction document control system.

1.06 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review Baseline Schedule, Schedule Updates, Schedule Revisions and Time Impact Analyses to ascertain compliance with specified project constraints, compliance with milestone dates, reasonableness of durations and sequence, accurate inter-relationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of Baseline Schedule within 21 calendar days after receipt.

C. Written comments on review of Schedule Updates and Schedule Revisions and Time Impact Analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit schedule in accordance with Engineer’s comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.

E. If Engineer requests a meeting, the Contractor and all major subcontractors must participate in the meeting with Engineer:
   1. Revise and resubmit schedule within 7 calendar days after meeting.

F. Use accepted schedule for planning, organizing, and directing the work and for reporting progress.

G. Engineer’s submittal review response:
   1. When schedule reflects Owner’s and Contractor’s agreement of project approach and sequence, schedule will be accepted by Owner.
   2. Engineer’s submittal review response for schedule submittal will be “Receipt Acknowledged - Filed for Record” including applicable comments.
3. Acceptance of the schedules by the Owner is for general conformance with the Contract Documents and for Owner's planning information and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the contract completion dates. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.07 SCHEDULE UPDATES

A. Any update:
   1. Prepare update using most recent accepted version of schedule including:
      a. Actual start dates of activities that have been started.
      b. Actual finish dates of activities that have been completed.
      c. Percentage of completion of activities that have been started but not finished.
      d. Actual dates on which milestones were achieved.
      e. Update activities by inputting percent complete figures with actual dates.
      f. Use retained logic in preparing Schedule Updates.
      g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
      h. Revisions to the schedule may be included that have been previously approved as specified in this Section under Revisions to Schedule.

B. Monthly updates:
   1. Submit written narrative report in conjunction with each Schedule Update including descriptions of the following:
      a. Activities added to or deleted from the schedule are to adhere to cost and other resource loading requirements:
         1) Identify added activities in manner distinctly different from original activity designations.
      b. Changes in sequence or estimated duration of activities.
      c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
      d. Assumptions made and activities affected by incorporating change order work into the schedule.
   2. Submit updated schedule and materials specified under Submittal of Progress Schedules, 5 calendar days before the monthly schedule update meeting.
   3. Since Monthly Schedule Update is the application for progress payment required as specified in Section 01_29_77 - Applications for Payment, submittal and acceptance of the monthly Schedule Update is a condition precedent to the making of any progress payments. Since the pay items as indicated on the drawings shall be updated in each application for payment, the progress schedule should include cash flow payment for each of the pay items.
1.08 REVISIONS TO SCHEDULE

A. Submit Revised Schedule within 5 calendar days:
   1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
   2. When delays in submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
   3. When the schedule does not represent the actual progress of activities.
   4. When any change to the sequence of activities, the completion date for major portions of the work, or when changes occur which affect the critical path.
   5. When Contract modification necessitates schedule revision, submit schedule analysis of change order work with cost proposal.

B. Create a separate submittal for Schedule Revisions:
   1. Comply with schedule updates as specified in this Section.
   2. Do not submit with Schedule Updates.

C. Schedule Revisions will not be reflected in the schedule until after the revision is accepted by the Owner:
   1. This includes Schedule Revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.09 ADJUSTMENT OF CONTRACT TIMES

A. Adjustment of contract times shall be in accordance with Section 00_72_00 General Conditions and Section 00_73_00 Supplemental Conditions.

B. Contract Time will be adjusted only for causes specified in Contract Documents and documented as required the General Conditions to the Contract as issued by TMUA. The contractor shall submit the "Extension of Time Request" form with each partial payment application:
   1. Non-excusable delay:
      a. Non-excusable delays include actions or inactions of the Contractor, or events for which the Contractor has assumed contractual responsibility (including actions or inactions of subcontractors, suppliers, or material manufacturers at any tier) that would independently delay the completion of the Work beyond the current Contract completion date).
      b. No time extensions will be granted for non-excusable delays.
   2. Excusable delay:
      a. Events which are unforeseeable, outside the control of, and without the fault or negligence of either the Owner or the Contractor (or any party for whom either is responsible), which would independently delay the completion of the Work beyond the current Contract completion date.
      b. The Contractor is entitled to a time extension only.
      c. No other damages will be approved.
   3. Compensable delay:
      a. Actions or inactions of the Owner, or events for which the Owner has assumed contractual responsibility, which would independently delay the completion of the Work beyond the current Contract completion date.
      b. The Contractor is entitled to a time extension and delay damages.
4. Concurrent delay:
   a. Concurrent delay is any combination of the above 3 types of delay occurring on the same calendar date.
   b. Exception to concurrent delay: Cases where the combination consists of 2 or more instances of the same type of delay occurring on the same calendar date. When one cause of delay is Owner-caused or caused by an event which is beyond the control and without the fault or negligence of either the Owner or the Contractor and the other Contractor-caused, the Contractor is entitled only to a time extension and no delay damages.

C. If the Contractor believes that the Owner has impacted its work, such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path:
   1. This proof, in the form of a Time Impact Analysis, may entitle the Contractor to an adjustment of Contract Time.

D. Time Impact Analysis:
   1. Use the accepted schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the schedule by:
      a. Inserting new activities associated with the delay event into the schedule.
      b. Revising activity logic.
      c. Revising activity durations.
   2. If the project schedule’s critical path and completion date are impacted as a result of adding this delay event to the schedule, a time extension equal to the magnitude of the impact may be warranted.
   3. The Time Impact Analysis submittal must include the following information:
      a. A fragment of the portion of the schedule affected by the delay event.
      b. A narrative explanation of the delay issue and how it impacted the schedule.
      c. A schedule file used to perform the Time Impact Analysis.
      d. Contractor must submit a Time Impact Analysis within 14 calendar days of reporting a potential impact to change in critical path.

E. When a delay to the project as a whole can be avoided by revising preferential sequencing or logic, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

F. Indicate clearly that the Contractor has used, in full, all project float available for the work involved in the request, including any float that may exist between the Contractor’s planned completion date and the Contract completion date:
   1. Utilize the latest version of the Schedule Update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

G. Adjustment of the Contract Times will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date:
   1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.
H. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

I. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to job-site or home office overhead beyond the Contractor's originally planned occupancy of the site.

J. Notify Engineer of a request for Contract Time adjustment:
1. Submit request as specified in the Contract Documents.
2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

K. The Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing:
1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule Update.
2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.10 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor’s intention to execute the Work within specified time and constraints:
1. Failure to conformance to requirement may result in termination for cause.

B. Contractor's bid covers all costs associated with the execution of the Work in accordance with the Progress Schedule.

C. During preparation of the preliminary Progress Schedule, Engineer will facilitate Contractor's efforts by being available to answer questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare schedule utilizing Precedence Diagramming Method (PDM).

E. Prepare schedule utilizing activity durations in terms of working days:
1. Do not exceed 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
3. Coordinate holidays to be observed with the Owner and incorporate them into the schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract:
   1. Contract requirements are not waived by failure of Contractor to include required schedule constraints, sequences, or milestones in schedule.
   2. Contract requirements are not waived by Owner's acceptance of the schedule. In event of conflict between accepted schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference schedule to working days with beginning of Contract Time as Day "1".

H. Baseline Schedule and Project Completion:
   1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's schedule completion date.
   2. Adjust accordingly any Contract milestone dates.

I. Imposed dates, hidden logic prohibited: Do not use imposed dates or hidden logic in preparation of schedule.

J. Interim milestone dates, operational constraints:
   1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on schedule.
   2. Do not use Zero Total Float constraint or Mandatory Finish Date on such Contract requirements.
   3. Owner acceptance of the Baseline Schedule creates the relationship of the schedule to the pay items as indicated on the drawings and specified in Section 01_29_73 - Schedule of Values.
   4. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01_29_77 - Applications for Payment.
   5. Payments will not be made until updated Schedule of Values is accepted.

1.11 NETWORK DETAILS AND GRAPHICAL OUTPUT

A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram:
   1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished:
   1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.
D. Indicate the critical path for the project.

E. Delineate the specified contract duration and identify the planned completion of the Work as a milestone:
   1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as project float unless a Change Order is issued to officially change the Contract completion date.

F. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion date as milestones.

G. Identify each pay item and how the completion of each of the pay items relates to the progress schedule.

H. Produce network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

1.12 WEATHER DAY ALLOWANCE

A. The quantity for Weather day allowance shall be in accordance with Section 00_72_00 General Conditions and Section 00_73_00 Supplemental Conditions.

B. Definition:
   1. Weather conditions that prevent or inhibit the Contractor’s performance of the Work and affect the Critical Path indicated on the Schedule shall be referred to as a Weather Day.
   2. A Weather Day is defined as the Contractor being unable to perform at least 4 hours of work on the Critical Path as established by the OWNER’s site representative.

C. Actual weather day:
   1. Insert a weather delay activity in critical path to reflect actual weather day occurrences when weather days are experienced and accepted by Owners site representative.
   2. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of project is considered float.
   3. The Contractor shall provide a written notice to the Engineer, signed/endorsed by the OWNER’s site representative of the occurrence of a weather day within 2 days after the onset of such weather and shall describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted:
      a. A schedule update will not suffice as a written notice.
      b. The Engineer will determine if the weather day constitutes a use of a portion of the Weather Day Allowance.
      c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.
      d. Weather days are considered excusable delay as defined in this Section.
1.13 ALLOWANCE FOR OWNER-CAUSED DELAY

A. The quantity of Allowance for Owner caused delay shall be in accordance with Section 00_72_00 General Conditions and Section 00_73_00 Supplemental Conditions.

B. Actual delay:
   1. Insert an activity in critical path to reflect actual Owner-caused delay occurrences when Owner-caused delay days are experienced and accepted by Engineer:
      a. Identify this activity as an Owner-caused delay.
   2. Reduce duration of Owner-Caused Delay Allowance activity as Owner-caused delays are experienced and inserted into the schedule. Remaining days in Owner-Caused Delay Allowance at completion of project is considered float.

1.14 PRELIMINARY SCHEDULE AND PRELIMINARY SCHEDULE OF VALUES

A. Due date:
   1. Submit proposed preliminary schedule and Payment Items within 14 calendar days after Notice to Proceed.
   2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule and Pay items to review and make necessary adjustments.
   3. Submit revised preliminary schedule and Pay Items within 5 calendar days after meeting.
   4. Update Preliminary Schedule and Preliminary Schedule of Values monthly during first 90 calendar days after Notice to Proceed:
      a. Use Preliminary Schedule and Pay Items as the payment application as specified in Section 01_29_77 - Applications for Payment.

B. Format:
   1. Schedule of manpower and costs for all activities for first 90 calendar days of Work after receipt of Notice to Proceed:
      a. Provide realistic and level manpower and costs so as not to have unusual manpower requirements.
   2. Schedule of costs:
      a. Schedule of Values as specified in Section 01_29_73 - Schedule of Values for first 90 calendar days of Work.
      b. Submittal and acceptance of Preliminary Schedule is condition precedent to making of progress payments as specified in Section 01_29_77 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.
      c. Proceed with pay item Work after Preliminary Schedule and schedule of costs have been accepted by Owner.

C. Incorporate unchanged, the accepted Preliminary Schedule as first 90 calendar days of activity in Contractor’s Baseline Schedule.

1.15 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include submittals required in the Contract Documents but not limited to test plans, training plans, test procedures, operation and
maintenance manuals, shop drawings, samples, record documents, and specifically required certificates, warranties, and service agreements:
1. Data for "Or Equals" or substitutions shall be submitted with the Schedule of Submittals.

B. Preliminary Schedule of Submittals:
1. Due date: After Preliminary Schedule has been submitted and accepted by Owner.
2. Format:
   a. Include submittals anticipated in the first 90 calendar days after award of contract using early start dates.
   b. Indicate week and month anticipated for submittal to Engineer.
   c. Indicate "Priority" submittals where review time can impact Contractor's schedule:
      1) "Priority" indication will not alter review times specified in Section 01_33_00 - Submittal Procedures.
      2) Engineer will endeavor to provide early review of "Priority" submittals where possible.
   d. List of "Or Equals" or substitutions.
3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after award of contract.

C. Final Schedule of Submittals:
1. Due date: 30 days after Baseline Schedule has been submitted and accepted by Owner.
2. Format:
   a. Include submittals using early start dates.
   b. Include all submittals, including those required in the Preliminary Schedule of Submittals.
   c. Indicate week and month anticipated for submittal to Engineer.
   d. Indicate "Priority" submittals where review time can impact Contractor's schedule:
      1) "Priority" indication will not alter review times specified in Section 01_33_00 - Submittal Procedures.
   e. Data for "Or Equals" or substitutions.
3. Submittal of Final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if schedule revisions change listing and timing of submittals.

1.16 BASELINE SCHEDULE AND BASELINE SCHEDULE OF VALUES

A. Due date: No more than 45 calendar days after Notice to Proceed.

B. Format:
1. Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
2. Schedule of Values: As specified in Section 01_29_73 - Schedule of Values.
1.17 SUMMARY SCHEDULE

A. Due date: At monthly progress meetings and after each Schedule Update or Schedule Revision.

B. Format:
   1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
   2. intended to give an overall indication of the project schedule without a large amount of detail.

1.18 COST FLOW SUMMARY

A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Section 01_29_77 - Applications for Payment.

B. Format:
   1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
   2. Base tabulation on the summation of the cost-loaded activities each month.
   3. Show planned amounts.
   4. Show all pay items as indicated on the drawings.
   5. Show actual earned amounts and anticipated remaining earnings.
   6. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

1.19 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

A. Due date: Submit on a monthly basis as specified in Section 01_29_77 - Applications for Payment.

B. Format: Schedule of Values: As specified in Section 01_29_73 - Schedule of Values.

1.20 WEEKLY SCHEDULE

A. Due date: At every Monthly progress meeting.

B. Format:
   1. Contractor and Engineer must agree on the format.
   2. 6-Week Schedule showing the activities completed during the previous week and the Contractor’s schedule of activities for following 5 weeks.
   3. Use the logic and conform to the status of the current progress schedule when producing a Weekly Schedule in CPM schedule or a bar chart format:
      a. In the event that the Weekly Schedule no longer conforms to the current schedule, Contractor may be required to revise the schedule as specified in this Section.
   4. The activity designations used in the Weekly Schedule must be consistent with.
1.21 FINAL SCHEDULE

A. The final Schedule Update becomes the As-Built Schedule:
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
   2. Contractor’s Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule Update is provided.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_32_34
PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for preconstruction and postconstruction photographs and videos.

B. The purpose of the photographs and videos is to document the condition of the facilities prior to the Contractor beginning work at the Project site, the progress of the Work, and the Project site after Substantial Completion of the Work.

C. The scope of the photographic and videographic documentation shall be the sole responsibility of the Contractor but shall be acceptable to the Engineer.

1.02 SUBMITTALS

A. Photographer qualifications.

B. Pre-construction photographs and videos: Submit prior to beginning any work at the Project site.

C. Construction photographs and videos: Submit with each application for payment.

D. Post-construction photographs and videos: Submit with project closeout documents as specified in Section 01_77_00 - Closeout Procedures.

1.03 PHOTOGRAPHER

A. Photographer qualified and equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to telephoto.

B. Submit example work of previous photographs and video recording meeting the requirements of this Section.
   1. Provide to Engineer no later than the pre-construction conference.
   2. Provide photographs used for site examination.
   3. Provide video of site examination.
   4. Provide samples that used same camera and lighting equipment proposed for the Work.
   5. Engineer will review work examples to determine if the quality of the images is acceptable.
   6. Contractor is responsible for modifications to equipment and/or inspection procedures to achieve report material of acceptable quality.
   7. Do not commence Work prior to approval of the material by the Engineer.
   8. Once accepted, the standard report material shall serve as a standard for the remaining work.
1.04 KEY PLAN

A. Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph.

B. Include the same label information as the corresponding set of photographs.

1.05 PHOTOGRAPHS

A. Provide prints of each photograph for each area of Work.

B. Provide a digital copy of each photograph for each area of Work.
   2. Project record documents:
      a. Catalog and index prints in chronological sequence.
      b. Include typed table of contents.

C. Provide flyover aerial drone photographs of each area of Work.
   1. Prior to first flight, meet with Owner and Engineer to define required photo views and Work areas to be photographed.
   2. Take 5 photos from each view.
   3. Views:
      a. Take photos at oblique angles from the north, south, east, and west directions.
      b. Take photos directly overhead.
   4. Some shots may cover the entire Project site and some may detail the areas under construction at the time of photography.
   5. Submit 5 proofs of each view within 7 calendar days of the date the photographs were taken.
      a. Engineer will select the preferred photograph from each view that will be printed.
   6. Frequency of flyover aerial digital photos: Quarterly

1.06 PRE-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs and video of the condition entire site including each area of Work prior to the start of Work.
   1. Areas to be photographed and videoed shall include the site of the Work and all existing facilities, either on or adjoining the Project site, including the interior of existing structures that could be damaged as a result of the Contractor’s Work.
   2. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.

1.07 CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs and videos of construction in each area of Work throughout progress of Work including a key plan designating where each photograph was taken.

B. Take site and interior photographs and videos from differing directions of building demolition, pre-excavation, footing excavation, soil testing, utility crossings, installation of bypass piping, excavation of access pits, installation of lining system in pipes, rehabilitation of manholes, building modifications, utilities, electrical and
instrumentation modifications, and other applicable activities indicating relative progress of the work.

C. Take photos a maximum of 7 calendar days prior to Submittal.

1.08 POST-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs of the entire site including each area of Work at the completion of Work.
   1. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.
   2. Take photos and video from same points in same direction as pre-construction examination.

B. Submittal of photos and videos is a condition of final payment.

1.09 DRONE OPERATOR:

A. Drone operator must have applicable pilots license and have at least three (3) construction projects of similar nature and size where both photographs, videos, and GPS based aerial surveys have been conducted.

B. Submit example work of previous photographs and video recording meeting the requirements of this Section:
   1. Provide to Engineer no later than the pre-construction conference.
   2. Provide photographs used for site examination.
   3. Provide video of site examination.
   4. Provide samples that used same drone camera and GPS equipment and software proposed for the Work.
   5. Engineer will review work examples to determine if the quality of the images is acceptable.
   6. Contractor is responsible for modifications to equipment and/or inspection procedures to achieve report material of acceptable quality.
   7. Do not commence Work prior to approval of the material by the Engineer.

C. Once accepted, the standard report material shall serve as a standard for the remaining work.

PART 2 PRODUCTS

2.01 MEDIA

A. Paper media:
   1. Commercial grade, glossy surface, acid-free photographic paper.
   2. Submit 3 prints of each photographic view within 7 days of taking photographs.
   3. Format:
      a. Ground photos: Color, matte finish, 8-1/2-inch by 11-inch size, mounted on soft card stock.
      b. Aerial photos: Color, matte finish, 11-inch by 17-inch size, mounted on soft card stock.
      c. Mount each print in a separate, archival type, non-glare, 3-hole punched protector.
4. Identification: On photograph, provide the following information:
   a. Name of project.
   b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
   c. Description of vantage point, indicating location and direction by compass point.

5. Provide a suitably sized 3-ring binder for each set of prints.
   a. Furnish binders in sufficient quantities to hold entire set of prints taken for the duration of the Contract.
   b. Label binder spine and front with project name.

B. Digital media:
   1. Flash drive compatible with current Microsoft Windows.
   2. Provide photos as individual, indexed JPG files with the following characteristics:
      a. Compression shall be set to preserve quality over file size.
      b. Highest resolution JPG images shall be submitted. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
      c. JPG image resolution shall be 5 megapixels at 2,400 by 1,800 or higher.
      d. Images shall have rectangular, clean images. Artistic borders, beveling, drop shadows, etc., are not permitted.
   3. Identification: On photograph, provide the following information:
      a. Name of project.
      b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
      c. Description of vantage point, indicating location and direction by compass point.

C. Videos:
   1. Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
   2. Digital color video format.
   3. Provide audio portion of the composite video sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
   4. Identification: On each copy provide a label with the following information:
      a. Name of project.
      b. Date video was recorded.
   5. Submit 1 copy of each video within 7 days of recording.
   6. Display continuous running time.
   7. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_33_00

SUBMITTAL PROCEDURES

PART 1    GENERAL

1.01 SUMMARY

A. Section includes: Requirements and procedures for submittals to confirm compliance with Contract Documents.

B. Quantities and format of submittals shall be in accordance with Section 00_72_00 General Conditions and Section 00_73_00 Special Provisions.

1.02 GENERAL INSTRUCTIONS

A. Contractor is responsible to determine and verify field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved shop drawings and Contract Document requirements.

B. Provide submittals:
   1. That are specified or reasonably required for construction, operation, and maintenance of the Work.
   2. That demonstrate compliance with the Contract Documents.

C. Where multiple submittals are required, provide a separate submittal for each specification section:
   1. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
      a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section.
      b. For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.

D. Prepare submittals in the English language. Do not include information in other languages.

E. Note the pay item(s) associated with each of the submittals as conformed to the schedule.

F. Present measurements in customary American units (feet, inches, pounds, etc.).

G. Must be clear and legible, and of sufficient size for presentation of information.
H. Page size other than drawings:
   1. Minimum page size will be 8 1/2 inches by 11 inches,
   2. Maximum page size will be 11 inches by 17 inches.

I. Drawing sheet size:
   1. Maximum sheets size: 22-inch by 34-inch:
      a. Minimum plan scale: 1/8-inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8 inch minimum.
   2. 11-inch by 17-inch sheet:
      a. Minimum plan scale: 1/8-inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8 inch minimum.

J. Show dimensions, construction details, wiring diagrams, controls, manufacturers,
catalog numbers, and all other pertinent details.

K. Provide submittal information from only 1 manufacturer for a specified product.
   Submittals with multiple manufacturers for 1 product will be rejected without review.

1.03 SUBMITTAL ORGANIZATION

A. Organize submittals in exactly the same order as the items are referenced, listed,
   and/or organized in the specification section.

B. For submittals that cover multiple devices used in different areas under the same
   specification section, the submittal for the individual devices must list the area
   where the device is used.

C. Bookmarks:
   1. Bookmarks shall match the table of contents.
   2. Bookmark each section (tab) and heading.
   3. Drawings: Bookmark at a minimum, each discipline, area designation, or
      appropriate division.
   4. At file opening, display all levels of bookmarks as expanded.

D. Where applicable (i.e., except for drawings, figures, etc.) submittal content shall be
   electronically searchable utilizing the PDF file as submitted.

E. Thumbnails optimized for fast web viewing.

F. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered
      pages, or are otherwise unacceptable, will be returned without review.

G. Attachments:
   1. Specification section: Include with each submittal a copy of the relevant
      specification section:
      a. Indicate in the left margin, next to each pertinent paragraph, either
         compliance with a check (✓) or deviation with a consecutive number (1,
         2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and
         reason for the deviation.
2. Drawings: Include with each submittal a copy of the relevant Drawing, including relevant addendum updates:
   a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
   b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

H. Contractor: Prepare submittal information in sufficient detail to show compliance with specified requirements:
   1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
   2. Coordinate submittal with other submittals and with the requirements of the Contract Documents.
   3. Check, verify, and revise submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

I. Contractor: Prepare "Or Equal" submittal information:
   1. Provide standard submittal requirements:
      a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
   2. Provide reason the specified product is not being provided.
   3. Explain the benefits to the Owner for accepting the "Or Equal".
   4. Itemized comparison of the proposed "Or Equal" with product specified including a list of significant variations:
      a. Design features.
      b. Design dimensions.
      c. Installation requirements.
      d. Operations and maintenance requirements.
      e. Availability of maintenance services and sources of replacement materials.
   5. Reference projects where the product has been successfully used:
      a. Name and address of project.
      b. Year of installation.
      c. Year placed in operation.
      d. Name of product installed.
      e. Point of contact: Name and phone number.
   6. Define impacts:
      a. Impacts to other contracts.
      b. Impacts to other work or products.
   7. Contractor represents the following:
      a. Contractor bears the burden of proof of the equivalency of the proposed "Or Equal".
      b. Proposed "Or Equal" is equal or superior to the specified product.
      c. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed "Or Equal", unless Owner requires a Special Warranty.
      d. Contractor will coordinate installation of accepted "Or Equal" into the Work and will be responsible for the costs to make changes as required to the Work.
e. Contractor waives rights to claim additional costs caused by proposed "Or Equal" which may subsequently become apparent.

J. Contractor: Prepare substitution submittal information:
   1. Provide standard submittal requirements:
      a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
   2. Provide reason the specified product is not being provided.
   3. Explain the benefits to the Owner for accepting the substitution.
   4. Itemized comparison of the proposed substitution with product specified including a list of significant variations:
      a. Design features.
      b. Design dimensions.
      c. Installation requirements.
      d. Operations and maintenance requirements.
      e. Availability of maintenance services and sources of replacement materials.
   5. Reference projects where the product has been successfully used:
      a. Name and address of project.
      b. Year of installation.
      c. Year placed in operation.
      d. Name of product installed.
      e. Point of contact: Name and phone number.
   6. Define impacts:
      a. Impacts to Contract Price:
         1) Required license fees or royalties.
         2) Do not include costs under separate contracts.
         3) Do not include Engineer's costs for redesign or revision of Contract Documents.
      b. Impacts to Contract Time.
      c. Impacts to Contract Scope.
      d. Impacts to other contracts.
      e. Impacts to other work or products.
   7. Contractor represents the following:
      a. Contractor shall pay associated costs for Engineer to evaluate the substitution.
      b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
      c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
      d. Proposed substitution is equal or superior to the specified product.
      e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless Owner requires a Special Warranty.
      f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
      g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.
1.04 **SUBMITTAL METHOD AND FORMAT**

A. Submittal identification numbering:
   1. Number each submittal using the format defined below:

<table>
<thead>
<tr>
<th>Spec Section Number</th>
<th>Dash</th>
<th>Initial Submittal - Sequential Number</th>
<th>Decimal Point</th>
<th>Subsequent Submittal Revisions Sequential Number</th>
</tr>
</thead>
</table>
   | **Example 1**
   | Description         |      | 8th initial submittal                 |               |                                               |
   | 00_30_00            | -    | 0008                                  |               |                                               |
   | **Example 2**
   | Description         |      | 8th initial submittal                 |               | First revision to the 8th initial submittal   |
   | 00_30_00            | -    | 0008                                  |               | 1                                             |

B. Submittals in electronic media format:
   1. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.

1.05 **SUBMITTAL PROCEDURE**

A. Engineer: Review submittal and provide response:
   1. Review description:
      a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
      b. Engineer's review of submittals shall not release Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall Engineer's review release Contractor from fulfilling purpose of installation nor from Contractor's liability to replace defective work.
      c. Engineer's review of shop drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
      d. Engineer's review does not extend to:
         1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by Contractor.
         2) Contractor's means, methods, techniques, sequences, or procedures except when specified, indicated on the Drawings, or required by Contract Documents.
3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.

e. Engineer can Approve or Not Approve any exception at their sole discretion.

2. Review timeframe:
   a. Except as may be provided in technical specifications, a submittal will be returned within 30 days.
   b. When a submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the submittal, give notice of the date by which that submittal will be returned.
   c. Engineer’s acceptance of progress schedule containing submittal review times less than those specified or agreed to in writing by Engineer will not constitute Engineer’s acceptance of review times.
   d. Critical submittals:
      1) Contractor will notify Engineer in writing that timely review of a submittal is critical to the progress of Work.

3. Schedule delays:
   a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer’s review of submittals, unless all of the following criteria are met:
      1) Engineer has failed to review and return first submission within the agreed upon time frame.
      2) Contractor demonstrates that delay in progress of Work is directly attributable to Engineer’s failure to return submittal within time indicated and accepted by Engineer.

4. Review response will be returned to Contractor with one of the following dispositions:
   a. Approved:
      1) No Exceptions:
         a) There are no notations or comments on the submittal and the Contractor may release the equipment for production.
      2) Make Corrections Noted - See Comments:
         a) The Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Resubmittal not required.
      3) Make Corrections Noted - Confirm:
         a) The Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer’s transmittal requiring the confirmation.
   b. Not approved:
      1) Correct and resubmit:
         a) Contractor may not proceed with the Work described in the submittal.
         b) Contractor assumes responsibility for proceeding without approval.
         c) Resubmittal of complete submittal package is required within 30 calendar days of the date of the Engineer’s submittal review response.
2) Rejected - See Remarks:
   a) Contractor may not proceed with the Work described in the submittal.
   b) The submittal does not meet the intent of the Contract Documents. Resubmittal of complete submittal package is required with materials, equipment, methods, etc. that meet the requirements of the Contract Documents.
   c. Receipt acknowledged - Filed for record:
      1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
   d. Receipt acknowledged with comments - Resubmit:
      1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.

B. Contractor: Prepare resubmittal, if applicable:
   1. Clearly identify each correction or change made.
   2. Include a response in writing to each of the Engineer's comments or questions for submittal packages that are resubmitted in the order that the comments or questions were presented throughout the submittal and numbered consistent with the Engineer's numbering:
      a. Acceptable responses to Engineer's comments are listed below:
         1) "Incorporated" Engineer's comment or change is accepted and appropriate changes are made.
         2) "Response" Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
      b. Reviews and resubmittals:
         1) Contractor shall provide resubmittals which include responses to all submittal review comments separately and at a level of detail commensurate with each comment.
         2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment. Responses such as "acknowledged" or "noted" are not acceptable.
         3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
         4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant submittals.
         5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.
   c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for Revision and Resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.
3. Resubmittal timeframe:
   a. Contractor shall provide resubmittal within 15 days.
   b. When a resubmittal cannot be returned within the specified period, Contractor shall notify Engineer in writing.

4. Review costs:
   a. Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
   b. Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

1.06 PRODUCT DATA

A. Edit submittals so that the submittal specifically applies to only the product furnished.

B. Neatly cross out all extraneous text, options, models, etc. that do not apply to the product being furnished, so that the information remaining is only applicable to the product being furnished.

1.07 SHOP DRAWINGS

A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of shop drawings.

B. Indicate project designated equipment tag numbers for submittal of devices, equipment, and assemblies.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
# CONTRACTOR SUBMITTAL TRANSMITTAL FORM

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**Specification No. and Subject of Submittal / Equipment Supplier**

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**Submittal Certification**

Check Either (A) or (B):

- **(A)** We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings with no exceptions.

- **(B)** We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings except for the deviations listed.

Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.

**General Contractor’s Reviewer’s Signature:**

**Printed Name:**

In the event, Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.

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**PM/CM Office Use**

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SECTION 01_35_21

SELECTIVE ALTERATIONS AND DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cutting or modifying of existing and new work.
   2. Partial demolition of structures, fencing, gates, electrical conduit, wires, pavement, etc., associated with the truck scale location, truck pullout location, and water treatment plant entrance.
   3. In-place abandonment of pipe.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A10.6 - Safety and Health Program Requirements for Demolition Operations.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 DEFINITIONS

A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.

B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.

C. Coring equipment: Non-impact rotary drill with diamond cutting edges.

D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

E. Salvage material: Materials removed from existing facilities and stored for Owner's future reuse.

1.04 DESCRIPTION OF WORK

A. The work includes partial demolition, cutting, and modifying of existing facilities, utilities, and/or structures as indicated on the drawings and specified herein.
B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and structures that are to remain in place and that are damaged by demolition or removal operations. See Section 01_50_00 Temporary Facilities and Controls.

1.05 SUBMITTALS

A. General:
   1. Submit specified in Section 01_33_00 - Submittal Procedures.

B. Shop drawings: Include:
   1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.

C. Submittals for information only:
   1. City of Tulsa Permits and notices authorizing demolition.
   2. Certificates of severance of utility services.
   3. Permit for transport and disposal of debris.
   5. Pipe Abandonment Plan.

D. Quality assurance submittals:
   1. Qualifications of non-destructive testing agency/agencies.

E. Project record documents.

F. Drawings and/or other media documenting locations of service lines and capped utilities.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
   2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

1.07 SEQUENCING

A. Perform Work in sequences and within times specified in Section 01_14_00 - Work Restrictions.

B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.
C. Coordinate the Work with operation of the facility:
   1. Do not begin alterations or demolition of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
   2. Complete Work as quickly and with as little delay as possible.

D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.

E. Owner will cooperate to assist in expediting the Work.

F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

1.08 REGULATORY REQUIREMENTS

A. Dispose of debris in accordance with governing regulatory agencies.

B. Comply with applicable air pollution control regulations.

C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

1.09 PROJECT CONDITIONS

A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.

B. Provide, erect, and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
   1. Do not close or obstruct roadways without permits.
   2. Conduct operations with minimum interference to public or private roadways.

C. Prevent movement, settlement, or collapse of structures adjacent services, sidewalks, driveways and trees:
   1. Provide and place bracing or shoring.
   2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
   3. Assume liability for movement, settlement, or collapse. Promptly repair damage.

D. Arrange and pay for capping and plugging utility services. Disconnect and stub off.
   1. Notify affected utility company in advance and obtain approval before starting demolition.
   2. Place markers to indicate location of disconnected services.

E. Unknown conditions:
   1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
2. Existing utilities and drainage systems below grade are located from existing
documents and from surface facilities such as manholes, valve boxes, area
drains, and other surface fixtures.
3. If existing active services encountered are not indicated or otherwise made
known to the Contractor and interfere with the permanent facilities under
construction, notify the Engineer in writing, requesting instructions on their
disposition. Take immediate steps to ensure that the service provided is not
interrupted, and do not proceed with the Work until written instructions are
received from the Engineer.

PART 2 PRODUCTS

2.01 SALVAGE MATERIALS

A. Materials designated for salvage:
   1. As determined by OWNER during preconstruction meeting.

B. Handling and storage:
   1. Prevent damage to salvaged materials during removal, handling, and
      transportation.
   2. Prepare salvaged materials for storage:
      a. Arrange with OWNER location to transport and unload at the site.
      b. OWNER will be responsible for storage.

C. Pay costs associated with salvaging materials, including handling, transporting, and
   storage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning selective demolition operations, perform a thorough inspection of
   the facility and site.
   1. Report to the Engineer defects, structural damage, and deterioration of
      existing construction to remain in place.

B. Examine areas affected by the Work and verify the following conditions prior to
   commencing demolition:
   1. Disconnection of utilities as required.
   2. Verify that utilities serving occupied or active portions of surrounding facilities
      will not be disturbed, except as otherwise indicated.

C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition
   operations until such conditions have been corrected.

3.02 PREPARATION

A. Plan and organize Work to minimize inconvenience to adjacent buildings and to
   plant operations.
B. Selective Demolition Plan:
   1. Prepare and submit a comprehensive selective demolition plan for the Work including the following elements, at a minimum:
      a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
      b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
   2. Submit plan a minimum 4 weeks before demolition is scheduled to begin.

C. Pipe Abandonment Plan:
   1. Prepare and submit a comprehensive Pipe Abandonment Plan for the Work.
      a. Include provisions to demonstrate and verify with camera inspection that all solids have been removed and that pipe is free of residuals.
   2. At a minimum, define the following elements:
      a. Proposed sequence, methods, cleaning procedures, or demolition, removal, and disposal of contents of the piping.
      b. Method of verification of final pipe condition.
      c. Detailed drawings showing treatment of pipe ends.
   3. Submit plan a minimum 4 weeks before abandonment is scheduled to begin.

D. Layout:
   1. The limits of selective demolition are indicated on the Drawings. Confine demolition operations within the limits indicated on the Drawings.
   2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required.
   3. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.
   4. Arrange for Engineer's inspection of the lay out extents.
   5. Do not begin demolition/removal operations until the lay out markings have been reviewed by the Engineer.

3.03 DEMOLITION

A. General:
   1. Perform demolition work in accordance with ANSI A10.6.
   2. Demolish designated portions of structures, pavement, fencing, gates, and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.
   3. Conduct demolition and removal work in a manner that will minimize dust and flying particles.
      a. Use water or dust palliative when necessary to prevent airborne dust.
      b. Provide and maintain hoses and connections to water main or hydrant.
   4. Remove materials carefully, to the extent indicated and as required.
      a. Provide neat and orderly junctions between existing and new materials.
      b. Use methods that terminate surfaces in straight lines at natural points of division.
   5. Do not remove anything beyond the limits of Work indicated without prior written authorization from the Engineer.
      a. If in doubt about whether to remove an item, obtain written authorization from the Engineer prior to proceeding.
   6. Perform work so as to provide the least interference and most protection to existing facilities to remain.
7. Demolished materials:
   a. Assume possession of materials unless otherwise indicated on the
      Drawings or specified.
   b. Remove demolished materials from site at least daily and dispose of
      them in accordance with Laws and Regulations.
   c. Do not burn or bury materials on site.

B. Demolition of concrete pavement, asphalt pavement, and masonry:
   1. Demolish concrete and masonry in small sections.
      a. Perform demolition with small tools as much as possible.
      b. Blasting with explosive charges is not permitted.
   2. Sawcut concrete to establish the edges of demolition, wherever possible.
      a. Do not use a concrete breaker within 6 inches of reinforcing or structural
         metals that are designated to remain in place.
      b. At edges that are not sawcut, remove the final 6 inches of material with a
         chipping hammer as defined herein. At surfaces where material is
         removed with a chipping hammer, follow with a heavy abrasive blast to
         remove all loose material and microcracking.
      c. Alternate techniques to remove concrete may be used if acceptable to the
         Engineer; however, techniques other than those deemed by ICRI
         Guideline No. 310.2R to provide a low risk of introducing microcracking
         will require a subsequent procedure to remove loose material and
         microcracked.
   3. At locations indicated on the Drawings where the existing reinforcing is to be
      preserved, remove concrete using methods that do not damage the
      reinforcing. Use one of the following techniques:
      a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
      b. Chipping hammer, as defined herein, followed by heavy abrasive blast to
         remove all loose material and microcracking at remaining surfaces
         impacted by the chipping hammer.
      c. Alternate methods may be used, only when accepted in advance by the
         Engineer.
      d. For all methods, provide a small completed area for Engineer's review
         and acceptance. If the proposed method, in the opinion of the Engineer,
         damages the reinforcing, revise the removal method to remove the
         concrete with a less aggressive technique to protect the reinforcing.

C. Sizing of openings in existing concrete or masonry:
   1. Make openings large enough to permit final alignment of pipe and fittings
      without deflections, but without oversizing.
   2. Allow adequate space for packing around pipes and conduit to ensure
      watertightness.
   3. If the Engineer deems the opening to be insufficient in size to accomplish this
      criteria, remove additional material using the procedures outlined in this
      Section.

D. Cutting openings in existing concrete or masonry:
   1. Do not allow saw cuts to extend beyond limits of openings.
   2. Create openings by the following method or other means acceptable to the
      Engineer that prevents over-cutting of member at corners:
      a. Core-drill through slab or wall at corners, being careful not to damage
         materials beyond the area to be removed.
b. Saw cut completely through the member, between the core holes at the corners.
c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth.
   1) Provide score on both surfaces (when accessible).
   2) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
   3) Remove the remaining material with a chipping hammer.
d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.

2. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

E. In-place Abandonment of Pipe:
   1. Abandoned pipe in-place as indicated on the Drawings.
   2. Provide closure of abandoned pipe cut ends as indicated on the Drawings using one of the following methods:
      a. Leave one end open.
      b. Install cap.
      c. Install plug.

F. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.

G. Remove trees and shrubs within marked areas, and clear undergrowth and dead plant material as specified in Section 31.00.00 - Earthwork.

H. Backfill open pits and holes caused by demolition as specified in Section 31.00.00 - Earthwork.

I. Rough grade areas affected by demolition.

J. Remove demolished materials, tools, and equipment upon completion of demolition.

3.04 RESTORATION

A. General:
   1. Repair damage caused by demolition to conditions equal to those that existed prior to beginning of demolition.
      a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface, and that matches color and texture of adjacent surfaces.
      b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
   2. The cost of repairs shall be at the Contractor’s expense at no increase in the Contract Price.
   3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
   4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.
5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
   a. Where change of plane between adjacent surfaces exceeds 2 inches, request and obtain instructions for making transition from Engineer.
      1) Refinish door surfaces and edges as necessary.
6. Trim existing doors as necessary to clear new floors.
7. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
8. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

B. Restore existing concrete reinforcement as follows:
   1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, conduits, and fasteners so little or no evidence of the previous installation remains:
   1. After removal of piping, conduit, fasteners, and other construction, fill areas in existing concrete and masonry floors, walls, and ceilings with non-shrink grout and finish smooth.
   2. Remove concrete bases for equipment and supports by:
      a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface.
         1) Do not cut existing reinforcement in slab.
      b. Chip concrete within scored lines.
      c. Cut exposed reinforcing steel and anchor bolts that will project above the repaired surface.
      d. Patch with non-shrink grout to match adjacent grade and finish.
   3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.
   4. Where existing fasteners are not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut fasteners flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut fasteners 1 inch below the surface, paint ends with epoxy, and patch holes with epoxy grout.
3.05 FIELD QUALITY CONTROL

A. Do not proceed with demolition without Engineer's inspection of lay out.

B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION
SECTION 01_35_73
DELEGATED DESIGN PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Delegated Design Procedures associated with the construction of:
   1. Truck Scale Pit, Sump Pump Pit, and Approach/Discharge Pads
   2. Truck Scale Cabinet Supports
   3. Electrical Grounding
   4. Lightning Protection
   5. Remove and Relocate Existing Guard House, See Appendix A of these technical specifications for shop drawings of the existing fabricated Guard House.
   6. Dimensions of the Trench Cover Installation.

1.02 DESIGN CRITERIA AND CONDITIONS – TRUCK SCALE PIT, SUMP PUMP PIT, AND APPROACH/DISCHARGE PADS

A. TMUA Codes and Standards:

B. Seismic Design:
   1. Seismic Design Category B.

C. Wind Load:
   1. Wind Load Minimum 36.9 PSF.
   2. Wind Speed Minimum 150 MPH.
   3. Exposure C.
   4. Wind Importance Factor 1.0.

D. Geotechnical Conditions:
   1. See Appendix B to these technical specifications for available boring logs for delegated design of the Truck Scale Pit, Sump Pump Pit, and Approach/Discharge Pads.

E. Minimum Excavation Requirements:
   1. Truck Scale Pit, Approach/Discharge Pads, and Sump Pump Pit minimum Dimensions and Depths as indicated on drawing S101.
   2. Excavation limits – Base Slab:
      a. Existing Material – As established by geotechnical report in Appendix A.
b. Depth below base slab of scale pit and sump pump pit.: 3 feet below or as determined by delegated design professional.

3. Excavation Limits – Perimeter Walls:
   a. Existing Material – As established by geotechnical report in Appendix B.
   b. Minimum Slope: 3:1 or as determined by Delegated design professional.

4. Excavation shall be in accordance with Section 31_20_00- Earth Moving.

F. Minimum Backfill Requirements:
1. Truck Scale Pit, Sump Pump Pit, and Approach/Discharge Pads Base Slab Foundation:
   a. From 0-1 feet below base slab: ODOT Type A aggregate base course compacted in accordance with Section 31_20_00 Earth Moving, Section 3.16 or as determined by delegated design professional.
   b. Non Woven Filter Fabric layer as manufactured by Propex, Geotex 401 or approved equal shall be provided between ODOT Agg base and engineered fill.
   c. From 1 feet to 3 feet below base slab: engineered fill in accordance with Section 31_20_00 Earth Moving compacted to 98 percent of standard proctor within lifts established in Section 3.13 or as determined by delegated design professional.

2. Truck Scale Pit and Sump Pump Pit Walls:
   a. Engineered fill in accordance with Section 31_20_00 Earth Moving, compacted to 98 percent of standard proctor within lifts established in Section 3.13 or as determined by delegated design professional.
   b. 6-inches topsoil

3. Backfill shall be in accordance with Section 31_20_00 Earth Moving and as indicated on the drawings 00GS01 and S101.

G. Minimum Cast In Place Concrete Design Requirements:
1. Minimum Volume of Concrete; Shall be as indicated on the drawings or as determined by the delegated design professional. 

2. General arrangement of concrete structure: Shall be as indicated on the drawings or as determined by the delegated design professional.

3. Location of Expansion Joints and Construction Joints Truck Scale Pit:
   a. Minimum of two continuous transverse expansion joints in wall and base slab or as determined by delegated design professional.
   b. Minimum of two additional transverse construction joints as determined by delegated design professional
   c. Location to be determined by delegated design professional.

4. Location of Expansion Joints; Provide designed expansion joints between the approach/discharge pads and the truck scale pump pit walls.

5. Design Approach/Discharge pads to bear on truck scale pit walls as indicated on the drawings.

6. Concrete Formwork: Shall be as Specified in Section 03_11_17 - Concrete Formwork or as determined by delegated design professional.

7. Cast In Place Concrete: Shall be Class A concrete as specified in Section 03_30_00 and indicated on Drawing 00GS01.

8. Tooled Concrete Finishes: Shall be as specified in Section 03_35_09 - Tooled Concrete Finishes.
H. Minimum Reinforcement Design Requirements:
   1. Reinforcement shall be designed without couplers or end reinforcement.
   2. Design lap splice lengths in accordance with ACI 318
   4. Minimum requirements for reinforcement design shall be as specified in Section 03_20_00 Concrete Reinforcement and as indicated on drawing GS02.
   5. Corner details shall be as indicated on the drawings or as determined by delegated design professional.

I. Grouting:
   1. Grouting of Truck Scale to Truck Scale Pit shall be designed by delegated design professional conforming to the requirements of Specification Section 03_60_00 Grouting.
   2. If grouting is to be utilized by design professional to provide minimum slopes of concrete indicated on the drawings, the concrete finish shall be as specified in Section 03_35_29- Concrete Finishes and the grout shall conform to Section 03_60_00 Grouting.

J. Water Tightness Design:
   1. Waterstops conforming to Section 03_15_00 Concrete Accessories shall be provided in the design professionals design for the Sump Pump Pit and Truck Scale Pit:
      a. At all locations where walls tie to the base slab.
      b. At expansion joints.
   2. Joint filler shall be as specified in Section 03_15_00- Concrete Accessories.
   3. Concrete Sealer waterproofing sealer shall be provided on all interior walls and slabs Sealer shall conform to Section 07_19_00- Water Repellants.

K. Mechanical Anchoring and Fastening to Concrete:
   1. Delegated design professional shall be responsible for determining the size, location, and design of the anchoring of the truck scale to the truck scale pit concrete foundation.
   2. Anchors shall be in accordance with Section 05_05_24 Mechanical Anchoring and Fastening to Concrete and as indicated on Drawing GS01 and GS02.
   3. Provide special inspections as required herein.

L. Special Tests and Inspections:
   1. Delegated design professional will be responsible to provide all special inspections, tests, and reports required by the referenced building codes for:
      a. Concrete Reinforcement
      b. Mechanical Anchoring to Concrete
      c. Metal Fabrications.

1.03 DESIGN CRITERIA AND CONDITIONS – TRUCK SCALE CABINET SUPPORTS

A. TMUA Codes and Standards:

B. Seismic Design:
   1. Seismic Design Category B.

C. Wind Load:
   1. Wind Load Minimum 36.9 PSF.
   2. Wind Speed Minimum 150 MPH.
   3. Exposure C.
   4. Wind Importance Factor 1.0.

D. Cabinet Design responsibilities:
   1. Truck Scale Cabinet shall be designed, procured, installed, tested and commissioned by Contractor.
   2. Truck Scale Cabinet shall be in accordance with the requirements of Specification Section 40_67_01 Control System Panels, Enclosures, and Panel Components and as indicated on the drawings.
   3. Foundation pad, cabinet supports, and anchoring of said cabinet supports to foundation pad shall be the responsibility of the delegated design professional.

E. Geotechnical Conditions:
   1. See Appendix B to these technical specifications for available boring logs for delegated design of the Truck Scale Cabinet and Supports.

F. Concrete support pad:
   1. Delegated design professional shall be responsible for designing the concrete support pad and reinforcing for the truck scale cabinet at size and the location indicated on the drawings.
   2. Concrete Formwork: Shall be as Specified in Section 03_11_17 - Concrete Formwork or as determined by delegated design professional.
   3. Cast In Place Concrete: Shall be Class A concrete as specified in Section 03_30_00 and indicated on Drawing 00GS01.
   4. Tooled Concrete Finishes: Shall be as specified in Section 03_35_09 - Tooled Concrete Finishes.

G. Metal Fabrications:
   1. Delegated design professional shall obtain Cabinet size, weights, center of gravity location, and dimensions from Contractor and shall design 316 stainless steel supports conforming to the requirements of Section 05_55_00- for procurement, fabrication, installation, testing and commissioning by the Contractor.
   2. Minimum requirements for metal fabrications:
      a. Unistrut will not be permitted.
      b. Utilize I-beams, H-Beams, C-Channels, or Metal Tubing.
      c. Minimum steel thickness: 3/8 inch
      d. Connections; Full Fillet welds
      e. Designed connection to Concrete utilizing mechanical anchoring.
f. Minimum lbs of 316 SS: 300lb

H. Mechanical Anchoring and Fastening to Concrete:
   1. Delegated design professional shall be responsible for determining the size, location, and design of the anchoring of the truck scale cabinet to the designed pad.
   2. Anchors shall be in accordance with Section 05_05_24 Mechanical Anchoring and Fastening to Concrete and as indicated on Drawing GS01 and GS02.
   3. Provide special inspections as required herein.

I. Special Tests and Inspections:
   1. Delegated design professional will be responsible to provide all special inspections, tests, and reports required by the referenced building codes for:
      a. Concrete Reinforcement
      b. Mechanical Anchoring to Concrete
      c. Metal Fabrications.

1.04 DESIGN CRITERIA AND CONDITIONS – RELOCATION OF EXISTING GUARD HOUSE.

A. TMUA Codes and Standards:
   1. International Building Code 2015. (for design of foundation and connections)

B. Appendix A provides the following:
   1. Original Specifications for the prefabricated steel guard House
   2. Contract drawings for the prefabricated steel guard House.

C. Appendix B provides geotechnical information regarding the general site.

D. Contractor shall provide a delegated design professional to:
   1. Obtain shop drawing and design calculations from the original manufacturer of the prefabricated steel guard house. Loads shall be as determined by the original design conditions referenced in Appendix A.
   2. Design foundation to support Guard House in accordance with those loads. Design shall conform to TMUA codes and standards referenced herein.
   3. Design anchors for connection of Guard House to the foundation. Design shall conform to TMUA codes and standards referenced herein.
   4. Coordinate with manufacturer of prefabricated steel guard house to identify and evaluate the existing lifting points and certify lifting points for moving guard house from existing to new location.
   5. Provide special inspections of designed components per referenced codes.

E. Contractor shall be responsible for the procurement, installation, testing and commissioning of the following:
   1. Guard house foundation as designed by delegated design professional.
   2. Guard house connections to foundation as designed by the delegated design professional.
   3. Guard house relocation as indicated in the drawings.
4. Connection of guard house utilities as indicated on the drawings and specified herein, including:
   a. Gate controls and pushbuttons
   b. Electrical power to guard house panelboard
   c. Card reader controls
   d. Security cameras feeds.

F. Minimum Excavation Requirements:
   1. Existing Material – As established by geotechnical report in Appendix B
   2. Depth of excavation below base slab of foundation: 4 feet below or as determined by delegated design professional.
   3. Minimum Foundation Dimensions:
      a. Type: Matt Foundation
      b. Depth: 3 feet.
      c. Length: 12 ft
      d. Width: 12 ft
   4. Minimum Slope: 3:1 of excavation or as determined by Delegated design professional.
   5. Excavation shall be in accordance with Section 31_20_00- Earth Moving.

G. Minimum Backfill Requirements:
   1. From 0-1 feet below base slab: ODOT Type A aggregate base course compacted in accordance with Section 31_20_00 Earth Moving, Section 3.16 or as determined by delegated design professional.
   2. Non-Woven Filter Fabric layer as manufactured by Propex, Geotex 401 or approved equal shall be provided between ODOT Agg base and native soil.
   3. Backfill shall be in accordance with Section 31_20_00 Earth Moving and as indicated on the drawings 00GS01.

H. Minimum Cast in Place Concrete Design Requirements:
   1. Minimum Volume of Concrete; Shall be 12'x12'x3.5' deep.
   2. General arrangement of concrete structure: Shall be as indicated on the drawings or as determined by the delegated design professional.
   3. Location of Expansion Joints between foundation and roadway:
      a. Location to be determined by delegated design professional.
   4. Concrete Formwork: Shall be as Specified in Section 03_11_17 – Concrete Formwork or as determined by delegated design professional.
   5. Cast In Place Concrete: Shall be Class A concrete as specified in Section 03_30_00 and indicated on Drawing 00GS01.
   6. Tooled Concrete Finishes: Shall be as specified in Section 03_35_09 Tooled Concrete Finishes.

I. Minimum Reinforcement Design Requirements:
   1. Reinforcement shall be designed without couplers or end reinforcement.
   2. Design lap splice lengths in accordance with ACI 318
   4. Minimum requirements for reinforcement design shall be as specified in Section 03_20_00 Concrete Reinforcement and as indicated on drawing GS02.
5. Corner details shall be as indicated on the drawings or as determined by delegated design professional.

J. Grouting:
1. Grouting of Guard House to foundation shall be designed by delegated design professional conforming to the requirements of Specification Section 03_60_00 Grouting.

K. Mechanical Anchoring and Fastening to Concrete:
1. Delegated design professional shall be responsible for determining the size, location, and design of the anchoring of the existing
2. Anchors shall be in accordance with Section 05_05_24 Mechanical Anchoring and Fastening to Concrete and as indicated on Drawing GS01 and GS02.
3. Provide special inspections as required herein.

L. Special Tests and Inspections:
1. Delegated design professional will be responsible to provide all special inspections, tests, and reports required by the referenced building codes for:
   a. Concrete Reinforcement
   b. Mechanical Anchoring to Concrete
   c. Metal Fabrications.

1.05 ELECTRICAL GROUNDING:

A. TMUA Codes and Standards:

B. Contractor shall provide a delegated design professional to:
1. Design grounding system for Truck Scale and Entrance in accordance with the requirements of the National Electric Code, 2017 edition.
2. Coordinate with lighting protection subcontractor to incorporate lighting protection system into grounding system design.
3. Provide shop drawings illustrating location and sizing of all grounding rods and cables.
4. Inspect contractors installation of grounding system.

C. Contractor shall be responsible for the procurement, installation, testing and commissioning of the electrical grounding system designed by the delegated design professional.
D. Minimum Requirements:
   1. Truck Scale:
      a. Ground rods:
         1) Quantity 4:
         2) As specified in Section 26_06_00 – Grounding and Bonding.
      b. Grounding Cable:
         1) Quantity: 320 LF
         2) As specified in Section 26_06_00 – Grounding and Bonding.
   2. Entrance:
      a. Ground rods:
         1) Quantity 8:
         2) As specified in Section 26_06_00 – Grounding and Bonding.
      b. Grounding Cable:
         1) Quantity: 100 LF
         2) As specified in Section 26_06_00 – Grounding and Bonding.

E. Delegated design professional shall furnish drawings indicating exact location of ground rods, depth, and routing of grounding cable at the truck scale and entrance locations.

F. Delegated design professional shall provide inspection services to review contractors’ installation of delegated grounding design.

1.06 LIGHTNING PROTECTION DESIGN:

A. Contractor shall be responsible to employ a lightning protection subcontractor to review the electrical system design and provide any and all additional equipment and materials needed in order to construct a master labeled UL or LPI certified lightning protection system.

B. Lightning protection subcontractor to design, furnish, and install a complete lightning protection system, connected to the facility grounding system at the following structures:
   1. Truck Scale
   2. Entrance (including prefabricated metal guard house)

C. Design:
   1. Conform to the requirements of the UL or LPI and NFPA standards for lightning protection systems:
   2. Components shall be listed in accordance with UL 96. Lightning protection system: NFPA 780; Class IIUL 96A master labeled or LPI certified system(s) protecting guard house and truck scale superstructure consisting of:
      a. Air terminals on roof(s).
      b. Bonding of structure and other metal objects.
      c. Grounding electrodes.
      d. Interconnecting conductors.
   3. Connect the lightning protection system to the facility grounding electrode:
      a. Provide common ground connections as necessary to the electric, gate controls, security, truck scale controls, etc.
4. The installing contractor is responsible for all costs associated with UL or LPI application/inspection of the lightning protection system, including any costs associated with re-inspection necessary to obtain the UL 96A Master Label or LPI 177 Certification.

D. Qualifications:

1. Manufacturer’s qualifications:
   a. Company specializing in lightning protection equipment with minimum 5 years of experience:
      1) Listed in section “Lightning Conductor, Air Terminals and Fittings” of the UL “Electrical Construction Materials Directory” for at least 5 years previous to this Contract's bid opening date.
   b. Approved Manufacturers:
      1) Erico.
      2) Harger Lightning and Grounding.
      3) Thompson Lightning Protection, Inc.
      4) VFC, Inc.

2. Installer’s qualifications: Member of the UL quality control program listed in section “Lightning Protection Installation” of the UL “Electrical Construction Materials Directory” or LPI-certified installer for installation of lightning protection systems for at least 5 years previous to this Contract’s bid opening date. The lightning protection system shall meet the applicable requirements of NFPA 780 and UL 96 and 96A or LPI 175 and 177.

3. Upon completion of installation the lightning protection contractor to have the building lightning system physically inspected by UL or in accordance with LPI requirements:
   a. Furnish a UL Master Label or LPI Installer Certified for the building:
      1) Application for the UL Master Label without a physical inspection by UL is unacceptable.

E. Submittals:

1. Furnish submittals as specified in Section 01_33_00 - Submittal Procedures.

2. Product data:
   a. Provide samples and pertinent catalog data for:
      1) Air terminals.
      2) Conductors.
      3) Connectors.
      4) Accessories.
      5) Include dimensions and materials of each component and include indication of listing in accordance with UL 96.

3. Shop drawings:
   a. Including but not limited to:
      1) Layout of air terminals with the respective configuration of the zone of protection.
      2) Grounding electrodes, and bonding connections to structure and other metal objects.
      3) Type, size and locations for:
         a) Terminal.
         b) Electrode.
         c) Conductor.
4) Conductor routing details.
5) Connection details.
6) Termination details.
7) Applicable air terminal and other calculations.

b. Details showing installation of air terminals, conductors, and connectors.

4. Certificates:
   a. Submit written confirmation of having obtained UL Master Label or LPI certification for each lightning protection system.
   b. Photocopy of UL or LPI Installers' Certificate(s) for installation of lightning protection systems.
   c. Proof of the manufacturer has been UL-listed for at least 5 years.
   d. Proof of the installer has been UL-listed or LPI-certified for at least 5 years.

5. Record Documents:
   a. Provide Record Documents as specified in Sections 01_77_00 - Closeout Procedures.
   b. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

6. Manufacturer's installation instructions.

F. Materials:
   1. Ground rods and below grade connectors:
      a. As specified in Section 26_05_26 - Grounding and Bonding.
   2. Ground plate: Copper.
   3. Conductors:
      a. Perimeters:
      b. Copper
   4. Down conductors:
      a. Copper
      b. Sized in accordance with UL or LPI and NFPA requirements.
      c. UL listed for the application.
   5. Cable fasteners:
      a. Electrolytically compatible with conductors and mounting surface:
         1) Spaced in accordance with LPI or NFPA requirements.
   6. Above grade connectors:
      a. Make connections between dissimilar metals with approved bimetallic connectors.
      b. Installed by trained personnel.
      c. UL listed for the application.
   7. Miscellaneous materials:
      a. Copper of type and size recommended by the manufacturer of the lightning protection system.
      b. Stainless steel bolts, screws, and other threaded fasteners.

G. Installation:
   1. Conductor installations:
      a. Install the lightning protection roof system(s) grounding and bending conductors exposed on flat roof areas and concealed at ridge roof areas.
      b. Install main downleads completely concealed and sleeved.
c. Other than for the purpose of protecting downlead conductors from damage up to 6 feet above grade level, do not use exposed conduits to conceal the downleads on the exterior of the outside walls.

d. Use minimum 1-inch PVC conduits to protect lightning system conductors from damage.

2. Clearances: Ensure 6-foot minimum distance required by NEC:
   a. From lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods.
   b. From lightning system conductors to open conductors of communication systems.
   c. From lightning protection grounding electrodes to electrodes of other grounding systems.

3. Extend air terminals a minimum of 12 inches above object to be protected.

4. Maintain horizontal or downward coursing of main conductor and ensure that bends have at least an 8-inch radius and that no bend of a conductor forms an included angle of less than 90 degrees.

5. Grounding electrode system:
   a. Coordinate placement with design professional for grounding design.

6. Interconnection of metals:
   a. Bond all metal bodies within 6 feet of the conductor to the system with approved fittings and conductor.
   b. Connections between dissimilar metals shall be made with approved bimetallic connections.
   c. Bond metal bodies of inductance located within 6 feet of a conductor or object with secondary bonds.

7. Bond all isolated metallic bodies at or below the roof subject to inductance and within 6 feet of lightning protection system conductors.

8. Provide necessary common grounds between the lightning protections system and the electric and telephone service entrance wires, TV and radio antenna grounds.

9. Ensure that air terminals are installed to withstand calculated wind force due to 100 miles per hour winds with a 1.3 gust factor without structural damage and without damage to integrity of the lightning protection system.

H. FIELD QUALITY CONTROL

1. Provide one of the following:
   a. The services of UL to physically inspect the entire lightning protection system and issue the UL Master Label:
      1) Furnish UL Master Label as evidence that the installation has met with UL 96A code requirements.
   b. Obtain LPI system certification reports and LPI system certification.

1.07 GENERAL

A. Delegated Design Professional - Professional design services assigned to the Contractor by express delegation in the Contract Documents. Work is “Delegated Design” where the Technical Sections require the Contractor to provide professional design services and to submit signed and sealed documents from a registered Professional Engineer in the United States:

1. Requirements of Delegated Design component as specified in the technical section and as indicated on the Drawings.
B. Contractor shall cause such Delegated Design services to be provided pursuant to the professional standard of care by a properly licensed design professional in the United States, whose signature and seal shall appear on drawings, calculations, specifications, certifications, and submittals prepared by such design professional:
1. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.
2. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.
3. Such design professional shall issue certifications of design required by Laws and Regulations.
4. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal shall bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under Delegated Design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

D. Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to a Delegated Design will be only for the following limited purposes:
1. Confirming that submittal is in conformance with the performance and design criteria specified in the Contract Documents.

1.08 SUBMITTALS

A. Contractor shall provide a submittal for each of the Delegated Design features:
1. Truck Scale Pit and Cabinet support submittals shall be in accordance with Section 10.88.01 Industrial Weighing Scales.
2. Remove and Relocate Existing Guard House, See Appendix A.
3. Electrical Grounding – As specified herein
4. Lighting Protection – as specified herein.
5. Dimensions of the Trench Cover Installation.

B. Delegated Design:
1. Product data:
   a. Details related to the Delegated Design as specified in technical sections to completely describe the system.
2. Design documents with signature and seal from the Contractor's Professional Engineer:
   a. Design documents include but are not limited to drawings, calculations, specifications, inspection reports, and certifications.
   b. Provide Foundation and Anchorage Requirements.
3. Lists and schedules:
   a. Prepare and submit lists or schedules of items where delegated.
C. Construction services:
   1. Contractor's Professional Engineer's comments on submittals.
   2. Other construction documents, as required.

1.09 ENGINEER RESPONSE TO DELEGATED DESIGN SUBMITTALS

A. The Engineer response will be either of the following:
   1. Approved. Make Corrections Noted - See Comments:
      a. The Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
      b. The review was for the limited purpose of determining that the document was stamped by a Professional Engineer and that such design is generally consistent with and will not negatively affect the design concept presented in the Contract Documents.
      c. A resubmittal for record purposes is expected and shall be provided prior to final completion.
   2. Rejected - See Remarks:
      a. Contractor may not proceed with the Work described in the submittal.
      b. The submittal does not meet the intent of the Contract Documents.
      c. Resubmittal of complete submittal package is required with materials, equipment, methods, etc. that meet the requirements of the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_45_00
QUALITY CONTROL

PART 1  GENERAL

1.01  SUMMARY

A.  Section includes:
   1.  Quality control and control of installation.
   2.  Tolerances.
   3.  References.
   4.  Mock-up requirements.
   5.  Authority and duties of Owner's representative or inspector.
   6.  Sampling and testing.
   7.  Testing and inspection services.
   8.  Contractor's responsibilities.

1.02  QUALITY CONTROL AND CONTROL OF INSTALLATION

A.  Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B.  Comply with manufacturers' instructions, including each step in sequence.

C.  When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D.  Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E.  Perform Work by persons qualified to produce required and specified quality.

F.  Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G.  Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H.  When specified, products will be tested and inspected either at point of origin or at Work site:
   1.  Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2.  Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I.  Do not ship products which require testing and inspection at point of origin prior to testing and inspection.
1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

B. National Institute of Standards and Technology (NIST).

1.05 PRODUCT REQUIREMENTS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.06 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner’s Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor’s attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor’s safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor’s employees or others.
E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in
determining when the Work is, in general, proceeding in accordance with
Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective,
does not conform to Contract Documents, or has been damaged; or whenever
there is defective material or equipment; or whenever Inspector believes the
Work should be uncovered for observation or requires special procedures.
   3. Conduct review of draft payment application, stored materials, and pay items
for each month.
   4. Adjudication of weather day determination.

1.07 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of
materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and
quality required of materials to be used in the Work for testing or
examination.
      b. Test materials in accordance with standards of national technical
organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates
satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to
determine quality of material.
   4. Assist Engineer in preparation of test specimens at site of work, such as soil
samples and concrete test cylinders.

C. Quality Control Testing: All testing, inspections, etc. associated with the
Contractor’s internal quality control shall be the responsibility of the contractor to
arrange and pay.

1.08 TESTING AND INSPECTION SERVICES FOR QUALITY ASSURANCE

A. The Owner’s independent testing firm will perform tests, inspections and other
services specified in individual specification sections and as required by Owner and
requested by the Engineer.

B. The qualifications of laboratory that will perform the testing, contracted by the
Owner or by the Contractor for quality control, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets "Recommended Requirements for Independent Laboratory
   4. Laboratory Staff: Maintain full time specialist on staff to review services.
   5. Testing Equipment: Calibrated at reasonable intervals with devices of
accuracy traceable to NIST or accepted values of natural physical constants.
6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NIST during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

C. Testing, inspections, and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

D. Contractor shall cooperate with Owner’s independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested:
   1. Notify Engineer and Owner’s independent testing firm 48 hours prior to expected time for operations requiring testing.
   2. Make arrangements with Owner’s independent testing firm and pay for additional samples and tests required for Contractor’s use.

E. Limitations of authority of testing Laboratory: Owner’s independent testing firm or Laboratory is not authorized to:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency or laboratory may not approve or accept any portion of the Work.
   3. Agency or laboratory may not assume duties of Contractor.
   4. Agency or laboratory has no authority to stop the Work.

F. Testing and employment of an Owner’s independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

G. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner’s independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

H. The Owner’s independent testing firm responsibilities will include:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Engineer.
   7. Attend preconstruction meetings and progress meetings.

I. Owner’s independent testing firm individual test reports: After each test, Owner’s independent testing firm will promptly submit electronically and 3 hard copies of report to Engineer and to Contractor. Include the following:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
5. Identification of product and specifications section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Certified test results stamped and signed by a registered Engineer in the state where the project is located.
10. Summary of conformance with Contract Documents.
11. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results.

J. Owner's independent testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
   1. Results of testing.
   2. Testing logs.
   3. Outstanding deficiencies.
   4. Various statistical data.
   5. Testing curves (up to 4 types) as required by the Engineer.

1.09 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.

B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Furnish electronically and 5 hard copies of product test reports.

E. Furnish incidental labor and facilities:
   1. To provide access to construction to be tested.
   2. To obtain and handle samples at Work site or at source of product to be tested.
   3. To facilitate inspections and tests.
   4. For storage and curing of test samples.

F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

G. Failed Tests:
   1. Payment of OWNER's Third-party testing firm shall be the responsibility of the CONTRACTOR for all failed tests.
PART 2  PRODUCTS (NOT USED)

PART 3  EXECUTION (NOT USED)

END OF SECTION
SECTION 01_50_00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction staking, construction aids, barriers and enclosures, security, access roads, temporary controls, field offices and sheds, and removal after construction.

1.02 REFERENCE

A. American National Standards Institute (ANSI).

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Submit as specified in Section 01_33_00 - Submittal Procedures.

1.04 CONSTRUCTION STAKING:

A. This work shall consist of furnishing, placing, and maintaining construction layout stakes necessary for the proper prosecution and inspection of the work under the contract.

B. Contractor shall exercise care in the preservation of stakes and benchmarks and have them reset when they are damaged, lost, displaced, or removed. Contractor shall use licensed land surveyor in the State of Oklahoma and suitable equipment for the layout work required.

C. Contractor shall set all additional stakes needed, such as offset stakes, reference point stakes, slope stakes, pavement, curb line and grade stakes, stakes for bridges, sewers, roadway drainage, pipe underdrains, paved gutter, fence, culverts, or other structures – and any other horizontal or vertical controls necessary to secure a correct layout of the work. Stake centerline/control line of temporary features, such as shoo-fly detours.

D. Contractor shall make stakes for line and grade adequate to maintain the specified tolerances for the operation being performed and satisfactorily to Engineer. Mark the station number and the distance from the centerline of construction on all grade stakes.

E. Contractor shall furnish platforms and equipment necessary for proper and safe access for checking the staking, and when significant errors occur, resurvey to satisfaction of the Engineer.
F. Contractor shall notify Engineer immediately of plan errors. Special surveys necessary to determine corrective action shall be responsibility of Engineer.

G. All work done under this Contract shall be done to the lines, grades, and elevations shown on the Drawings. All lines and grades shall be furnished by the Engineer, but the Contractor shall provide all batter boards, straight edges, and other materials for lines, levels, and measurements; and shall set all batter boards under direction of the Engineer. The Contractor shall give the Engineer at least 48 hours' notice as to the location where stakes are required.

1.05 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
   2. Arrange for, provide, maintain, and pay for electric power for performance of the Work.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
   2. For the access gate, provide temporary lighting that, at a minimum, maintains the lighting levels provided by the current lighting arrangement.
   3. When available, permanent lighting facilities may be used in lieu of temporary facilities.

C. Temporary heating, cooling, and ventilating:
   1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
   2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:
   1. Arrange and pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
   2. Remove temporary piping and connections and restore affected portions of the facility to original condition before.

E. Temporary sanitary facilities:
   1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
   2. Existing facility use is not allowed.
   3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

1.06 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Provide devices in accordance with minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in public right-of-way:
   1. Comply with City of Tulsa standards and requirements for right-of-way barricades and other safety devices.
   2. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
      a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
   3. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
      a. During hours of darkness, provide warning lights at close intervals.

H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

I. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.
J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

K. Fences:
   1. Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence, and vandalism.
   2. Any temporary fence must be as good or better than the existing security fence.
   3. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to final completion.
   4. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons:
      a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
   5. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
   6. Fence temporary openings when openings are no longer necessary.

1.07 SECURITY

A. All Contractor’s, Subcontractors, suppliers, etc. working at the AB Jewell WTP shall undergo the security and background checks required by the provisions of Section 00_72_00 General Conditions and Section 00_73_00 Supplemental Conditions. The contractor shall use the company approved by TMUA to complete the background checks.

B. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

C. CONTRACTOR shall be responsible for furnishing a security guard under any and all of the following conditions:
   1. All times when fully functioning temporary or permanent fencing and gates are not in place.
   2. When existing plant access gates or new gates are incapable of operating in automatic mode as intended by the contract documents.
   3. During the time between gate installation and training, testing, and commissioning of the access gates.

D. Temporary Guard Shack: Contractor shall be responsible for providing a temporary guard shack for the existing plant Security personnel during all times in which the existing guard shack is not fully tested and commissioned and/or is in a location where it cannot serve its function.
   1. The temporary guard shack shall be of all weather, 50 sft minimum, heated and cooled, provide the environment for the OWNER’s Security Guard to perform his responsibilities in the control of the main entrance to the facility.
   2. Temporary paving shall accompany the temporary guard shack to provide access between the vehicles entering the facility and temporary guard shack.
E. CONTRACTOR furnished Security Guard Responsibilities:
   1. The inspection of vehicles as they are entering and exiting the Owner’s facilities according to Owner’s procedures.
   2. Risk Management Plan Conformance:
      a. Capturing and maintaining accurate logbook on all personnel on the site during the performance of the work and making certain those personnel have been adequately trained by Owners’ staff in accordance with the Owners Risk Management Plan.
      b. Reviewing logbook each day with Owner’s designated representation to ensure all personnel on site have been trained on the Risk Management Plan.
   3. Notify the Persons Entering of any hazards, safety violations or other conditions that warrant an unsafe condition.
   4. Perform additional duties unique to the post as required by Contractor.
   5. A majority of the duties will be stationary, but occasionally walking and/or driving may be required. In addition, manually opening and closing of access gates may be required during the period between installation and fully commissioning and testing of the entrance gates.
   6. Guards will not carry weapons of any kind.

F. CONTRACTOR furnished Security Guard Qualifications:
   1. Owner will reserve the right, at its sole discretion, to require the Contractor to remove any guard for any lawful reason and request a suitable replacement from the Contractor.
   2. Contractor will be responsible for the hiring and training of all guards, including any replacement of existing guards in accordance with TMUA standards.
   3. To the extent permitted by law, and at Contractor’s sole cost and expense, Contractor shall be responsible for conducting criminal background checks on all guards used to perform any services for Owner and for certifying to Owner that there is nothing revealed by such background checks of said guards that would create a reasonable doubt about the utilization of same for the services in a safe manner and with proper regard for the security of Owner and its employees, affiliates, subsidiaries, customers, vendors and other third parties. The contractor shall use the company approved by TMUA to complete the background checks.
   4. Contractor shall be responsible for certifying that any and all guards whose background checks indicate the following convictions shall not be assigned to the project:
      a. Any felony conviction -any conviction resulting in time spent in jail -more than one misdemeanor of any kind (excluding traffic violations) -any sex offense -any offense involving a weapon -any offense involving violence - any crime against a previous employer -and any crime involving fraud -theft -deception, etc.
   5. Contractor shall be responsible for ensuring that its guards strictly comply with owner’s drug-free workplace policies, as the same may be amended by Owner in its sole discretion.
   6. Security guards shall have a CLEET license for an unarmed security guard.
1.08 ACCESS ROADS

A. General:
   1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
   2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.

B. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.
   2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
   3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
   4. Maintain on-site access roads free of mud.
   5. Provide controls to prevent vehicles leaving the site from tracking mud off the site onto the public right-of-way.

1.09 PROJECT SIGN:

A. Provide a project sign as required by the City of Tulsa Standard Specifications (2022)

1.10 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

C. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. See Drawing for Vehicle Tracking Rock Pad

1.11 CONTRACTOR FIELD OFFICES AND SHEDS

A. Maintain on Project Site weather tight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.
1.12 REMOVAL

A. Remove temporary facilities and controls before inspection for Final Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_55_26
TRAFFIC CONTROL

PART 1   GENERAL

1.01 SUMMARY

A. Section includes:
   1. Providing safe and effective work areas and to warn, control, protect, and expedite vehicular and pedestrian traffic through the construction zone. It shall be the sole responsibility of the Contractor to provide for the safety of the traveling public within the limits of the project, including work in the public right-of-way and on private property.
   2. Section includes temporary construction, barricades and enclosures, fences, security, temporary controls, and traffic regulation.
   3. In this Section, reference to the “Public” also includes the Owner’s personnel and representatives.

B. All traffic control shall be in accordance with the City of Tulsa Traffic Engineering Division’s Standards and Procedures for Street Use and Temporary Traffic Control. Safety and traffic control devices shall be installed and removed only at the direction of the Engineer

1.02 SUBMITTALS

A. Approved and signed copies of:
   1. Traffic control plan (TCP) in conformance with TMUA requirements.

1.03 TRAFFIC CONTROL PLAN (TCP)

A. Approval of the TCP shall in no way relieve the Contractor of the responsibility for traffic and safety requirements.

B. Include labor, material, equipment, tools, and services used in the regulation of construction traffic to and from the project site as well as public vehicular and pedestrian traffic within the project limits.

C. TCP constraints:
   1. Access to all local streets shall be maintained at all times, except as noted. Turn lanes are not considered as travel lanes. Provide one travel lane that is 12 feet wide in each direction at all times.
   2. The TCP is to address the sequencing of the construction of the Main Entrance so that security, plant access and chemical deliveries are always available. Temporary measures shall be provided as required.
   3. Construction of the Truck Scale shall not preclude the ability to receive chemical deliveries during construction. Temporary measures shall be provided as required.
   4. Construction of the intersection near the Raw Water Chemical Building shall not preclude the ability to receive chemical deliveries. Temporary measures shall be provided as required.
B. Danger Signals and Protection: When the Contractor is performing any type of construction or excavation work, or is stockpiling or storing any materials or equipment upon or adjacent to any street, alley, sidewalk, residence, public ground, or other location that is likely to be subject to pedestrian or vehicular traffic, he shall furnish, erect, and maintain substantial guard rails, safety fencing, lights, and traffic control devices around the project to protect pedestrians, animals, and vehicles from injury or damage. All traffic control shall be in accordance with the City of Tulsa Traffic Engineering Division's Standards and Procedures for Street Use and Temporary Traffic Control. Safety and traffic control devices shall be installed and removed only at the direction of the Engineer. The Contractor shall provide sufficient proper signals and flagmen for warning during construction, excavation, and blasting operations.

C. Interference with Traffic: The Contractor shall construct and maintain adequate and safe bridges or crosswalks over excavations, where required. When a roadway or sidewalk is not closed, the Contractor shall provide a safe substitute route for any portion obstructed by his operations. If a roadway or sidewalk is closed to traffic, the Contractor shall provide and mark detours. As directed by the Engineer, construction across roadways or sidewalks may be done by open excavation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01_71_23
FIELD ENGINEERING

PART 1         GENERAL

1.01  SUMMARY

A.  Section includes:
   1.  Field engineering to establish lines and grades for the Work.
   2.  Field engineering to track and record as built conditions with aerial drone.

1.02  SUBMITTALS

A.  Submit as specified in Section 01330 - Submittal Procedures.

B.  Qualifications of the professional land surveyor or registered civil engineer in the state where project is located that will be performing the field engineering.

PART 2         PRODUCTS (NOT USED)

2.01  AERIAL DRONE SURVEY EQUIPMENT

A.  Drone Type: Multicopter or Fixed Wing.

B.  Drone Camera:
   1.  Minimum 20 MP.
   2.  35 MM Focal Length.
   4.  Image Height 3648px.
   5.  Sensor Width 13.2mm.
   6.  Sensor Height 8mm.
   7.  Focal Length 8.8mm.

C.  Drone Ground Sample Distance at 120m cm/pixel : Maximum 5.2.

D.  Fully Articulating Camera and large body mounted sensor.
E. Any of the following Drones:

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<th>Focal Length (mm)</th>
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F. Drone Software Processing:
1. Provide software to convert drone footage to CAD Based survey file for incorporation into as-built documents.
2. Software/Service Providers:
   a. Pix 4D.
   b. Drone deploy.
   c. Or Equal.

PART 3 EXECUTION

3.01 SURVEY REFERENCE POINTS

A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided by Owner.

B. From these reference points, establish other control and reference points as required to properly lay out the Work.

C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
   1. Make no changes or relocations without prior written notice.
   2. Replace Project control point, when lost or destroyed, in accordance with original survey control.

D. Set monuments for principal control points and protect them from being disturbed and displaced:
   1. Re-establish disturbed monuments.
   2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.
3.02 PROJECT SITE SURVEY REQUIREMENTS

A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.

B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.

C. Perform verifications and checking in accordance with standard surveying practice.

D. Maintain complete, accurate log of control points and survey.

E. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

3.03 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

3.04 QUALITY CONTROL

A. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Engineer's check does not substitute or complement required field quality control procedures.

3.05 POTHOILING REQUIREMENTS

A. Verify locations of utilities which may exist by consulting with the Owner, utility companies, and OKIE 811 or other service available in area of Project:
   1. Abide by easement and right-of-way restrictions.

B. Perform exploratory vacuum excavation potholing, as necessary to more accurately identify location, depth, configuration, and utility service in congested utility areas prior to preparation of shop drawings and subsequent excavation:
   1. Prior to backfilling, conduct aerial drone point/elevation survey of underground utility location and place in CAD file documenting as built conditions of utilities.
   2. Potholing shall be backfilled immediately after purpose has been satisfied and the surface restored and maintained in a manner satisfactory to Engineer.
   3. Adjustments in construction methods shall be made to accommodate utility location information gained from potholing as necessary to protect existing utilities and maintain plant in operations.
   4. Note that installation of all underground yard piping and utilities in this project are considered to be installed in congested utility areas.
   5. Some variation from the conditions indicated on the Drawings is to be expected.
B. Potholing is considered a necessary part of the Contractors work and shall be conducted at no additional cost to Owner.

C. Notify the Owner, owners of facilities when the Work will be in progress.

D. Make arrangements for potential emergency repairs in accordance with requirements of owners of utility facilities, including individual or residential facilities.

E. Assume responsibility for repair of utilities and facilities damaged by performance of the Work.

F. Expose sanitary and storm sewers, water, gas, electric, telephone utility lines, and other underground facilities to permit survey location prior to commencement of Work in affected area:
   1. Expose in ample time to permit relocation of interfering utilities with minimum delaying effect on Contract Time.
   2. Record utility location, size, materials, eccentricity, and locations of nearest joints at or near proposed tie-in locations on the Record Drawings.

G. Work required for raising, lowering, or relocating utilities not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities:
   1. When part of the Work, perform work in accordance with standards of affected utility owner, and adjustment to Contract Price and Contract Times will be made as stipulated in conditions of Contract.

3.06 QUALITY CONTROL

A. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Engineer's check does not substitute or complement required field quality control procedures.


3.07 RECORD DOCUMENTS

A. Prepare and submit Record Documents as specified in Section 01770 - Closeout Procedures.

B. Submit for review and approval a Coordinate and Elevation Table and CAD point survey File for underground utilities as specified herein:
   1. Contractor is responsible for providing top of pipe elevations and coordinate points for all underground piping 4-inches and larger including, but not limited to:
      a. All utility piping and conduits identified in potholing as specified herein.
   2. Contractor is responsible for providing top of ductbank elevations and coordinate points for all new electrical duct banks.
   3. Contractor is responsible for providing coordinate points for all new natural gas piping.
4. Datum:
      State Plane Coordinate System (Lambert Conic Projection in the state of
      OK).

5. Format:
   a. Survey CAD file tied to known benchmarks with coordinate points.
   b. Excel spreadsheet containing:
      1) Pipe ID.
      2) Northing.
      3) Easting.
      4) Top of pipe elevation.
      5) Size.
      6) Service.

C. Aerial Drone GPS Survey: Contractor shall conduct a drone based aerial GPS as
   built survey of the AB WTP Site for all areas of the work to Establish As Built
   Conditions:
   1. Topographic survey shall include all surface features and minimum 1 foot
      contours.
   2. Contractor shall provide both an electronic file importable into AUTOCAD
      software (.DWG extension 2018) and electronic PDF File (.PDF Extension) of
      the topographic survey to the ENGINEER. Included in the topographical
      survey will be the following:
         State Plane Coordinate System (Lambert Conic Projection in the state of
         OK).
      c. Surface elevations shall be on a 50 foot grid.
      d. Boundary monuments: Utilize existing.
      e. Benchmarks: as indicated on the drawings.
      f. New Surface Features:
         1) Fence sizes (height), Gate size, Gate Locations, and fence type.
         2) Tree sizes (caliper).
      g. New or modified Pavements (Streets, sidewalks, etc.):
         1) Names.
         2) outside edge of pavement (shoulder).
         3) edge of driving lane, and curb and gutter.
         4) Centerline.
         5) Types of Surface.
      h. All aboveground improvements including Utility Services, power pole
         locations, supporting guywire locations, etc.
      i. Manhole, Chemical Trenches and Utility Structures:
         1) Service: NEW or modified existing Storm water, sanitary, electrical,
            Cleanwell Drainage piping.
         2) Top of manhole and manhole rim elevation.
         3) Top of Trench Elevation and Bottom of Trench Elevations.
         4) Curb inlets, number of grates, hoods, and Flow line elevations.
         5) Size, flow line, and direction of flow for all new storm sewer, Sanitary
            Sewer, electrical Duct Banks, and clearwell drain piping and conduits
            located in structures and manholes.
         6) Headwalls or End sections on cross drains.
7) Size and type of cross drains.
8) Ditch, stream, and Creek Flow lines.

j. Relocated guard house, truck scale pit and approach/discharge pad installation, and aboveground electrical transformer/electrical switch information:
   1) Location of Building corners and corners of electrical gear support pad.
   2) Finished floor elevation of building ground floor.
   3) Finished elevation of truck scale, approach/discharge pads, truck cabinet pads, etc.
   4) Top of pad elevation for support pads for all electrical transformers, gear, etc.

3.08 RECORD DOCUMENTS

A. Prepare and submit Record Documents as specified in Section 01_77_00 - Closeout Procedures.

B. Provide certified site survey in native CAD file including buildings, benchmarks, and appurtenances sealed and signed by professional land surveyor or registered civil engineer:
   1. File with permitting agency, as required.

3.09 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

C. Provide Construction Staking as specified in Section 01_50_00 Temporary Facilities and Controls.

3.10 QUALITY CONTROL

A. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Engineer's check does not substitute or complement required field quality control procedures.

END OF SECTION
SECTION 01_77_00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Contract closeout requirements.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Final Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from Owner of such property.

B. Do not create unsightly or unsanitary nuisances during disposal operations.

C. Maintain disposal site in safe condition and good appearance.

D. Complete leveling and cleanup prior to Final Completion of the Work.
1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Final Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 CLOSEOUT DOCUMENTS

A. Submit the following Closeout Submittals before Substantial Completion:
   1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.
   7. Completed contract requirements for commissioning and process start-up.

B. Submit the following Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punch list of items have been completed and Engineer and Owner are satisfied that all deficiencies are corrected.
   2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
   4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
   6. Submit Final (As-Built) Schedule as specified in Section 01_32_21 - Schedules and Reports.

1.07 PROJECT RECORD DOCUMENTS

A. Maintain at Project site, available to Owner and Engineer, 1 copy of the Contract Documents, shop drawings, and other submittals in good order:
   1. Mark and record field changes and detailed information contained in submittals and change orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
   4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
   5. Provide schedules, lists, layout drawings, and wiring diagrams.
6. Make annotations in electronic format conforming to the following color code:

<table>
<thead>
<tr>
<th>Additions:</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deletions:</td>
<td>Green</td>
</tr>
<tr>
<td>Comments</td>
<td>Blue</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Graphite</td>
</tr>
</tbody>
</table>

B. Maintain documents separate from those used for construction:
1. Label documents "RECORD DOCUMENTS."

C. Keep documents current:
1. Record required information at the time the material and equipment is installed and before permanently concealing.
2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for Engineer's recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01_32_21 - Schedules and Reports.

1.08 MAINTENANCE SERVICE

A. Maintenance service as specified in technical specifications.

1.09 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.10 PRECONSTRUCTION AND POSTCONSTRUCTION VIDEO:

A. Provide in accordance with Section 01_32_34 photographic and videographic documentation.

1.11 AS BUILT DRONE SURVEY:

A. Provide in accordance with Section 01_32_34 photographic and videographic documentation.
1.12 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
   1. Work has been completed in accordance with the Contract Documents.
   2. Punch list items have been completed or corrected.
   3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or
defective work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies and
      send a second written certification to the Engineer that the Work is complete.
   3. Engineer shall re-inspect the Work.

1.13 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final
   Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount:
   1. The original Contract amount.
   2. Additions and deductions resulting from:
      a. Change Orders.
      b. Units installed and unit prices.
      c. Set-offs for uncorrected or incomplete Work.
      d. Set-offs for liquidated damages.
      e. Set-offs for reinspection payments.
      f. Extended engineering and/or inspection services and inspection overtime.
      g. Excessive shop drawings review cost by the Engineer.
      h. Other adjustments.
   3. Total Contract amount, as adjusted.
   4. Previous payments.
   5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the
   Contract amount which were not previously made by Change Orders.

1.14 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment reflecting the agreed upon
   information provided in the final statement of accounting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork for use with the Truck Sump Pit Concrete
deleated design as specified in Section 01_35_73- Delegated Design Procedures.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specifications for Tolerances for Concrete Construction and Materials
       and Commentary.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

C. Underwriters Laboratories (UL).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital
   letters, but, when used in this Section, have the indicated meaning.
   1. Green Concrete: Concrete with less than 100 percent of the minimum
      specified compressive strength ($f'_c$).

1.04 SUBMITTALS

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure themselves that
      intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be
      submitted.

B. Form release agent. NSF 61 certification prepared by NSF, Underwriters
   Laboratories (UL) or other, similar, nationally recognized testing laboratory
   acceptable to the Engineer.

1.05 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by
   manufacturers having a minimum of 5 years of experience, except as otherwise
   specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install work of this Section in accordance with local, state,
   and federal regulations.
PART 2  PRODUCTS

2.01  DESIGN AND PERFORMANCE CRITERIA

A.  Design requirements:
1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B.  Performance requirements:
1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on Drawing S101 and specified by delegated design professional.
2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
4. Use forms that are clean and free from dirt, concrete, and other debris.  
   a. Coat with form release agent if required, prior to use or reuse.

2.02  MANUFACTURED UNITS

A.  Forms: Built-up plywood:
1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
   a. Size and material:
      1) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
      2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
   b. Wales: Minimum 2-inch by 4-inch lumber.
   c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

B.  Forms: Steel or steel framed:
1. Steel forms:
   a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
   b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
2. Steel framed plywood forms:
   a. Provide forms that are rigidly constructed and capable of being braced.
   b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

C.  Form release agent.
1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.
D. Form ties:

1. General:
   a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
   b. Do not use wire ties or wood spreaders of any form.
   c. Provide ties of type that accurately tie, lock, and spread forms.
   d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
   e. Do not allow holes in forms for ties to allow leakage during placement of concrete.

2. Cone-snap ties:
   a. Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
   b. Provide neoprene waterseal washer that is located near the center of the concrete.

3. Taper ties:
   a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

E. Incidentals:

1. External angles:
   a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
   b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, and construction joints.

2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:

1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms: Built-up plywood:

1. Studding:
   a. Spaced at 16 inches or 24 inches on center.
   b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
   c. Install studs perpendicular to grain of exterior plys of plywood sheets.

2. Wales: Form wales of double lumber material with minimum size as specified in this Section.
3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Adequately brace forms for minimum deflection of finish surface.
   2. Steel framed plywood forms:
      a. Rigidly construct and brace with joints fitting closely and smoothly.
      b. Number of form reuses: Depends upon durability of surface coating or overlay used.
   3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

C. Form bracing and alignment:
   1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
   2. Formwork:
      a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.
      b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.
   3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:
      a. Spreading and vertical or horizontal displacement of forms.
      b. Grout "bleeding" on finish concrete surfaces.
   4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.
   5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

D. Forms: Incidentals:
   1. Keyways: Construct as determined by the delegated design professional.
   2. Reentrant angles: May be left square.
   3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.
   4. Inserts:
      a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as required by delegated design professional to integrate the scale into the design of the truck scale pit, in concrete.
   5. Pipe and conduit penetrations:
      a. Install pipe and conduit in structures by delegated design professional to integrate the scale into the design of the truck scale pit, and seal with PVC link seal.

E. Form release agent:
   1. Apply in accordance with manufacturer’s instructions.
F. Form ties:
   1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically
      and horizontally.

3.03 FORM REMOVAL

A. General:
   1. Keep forms in place, as specified in the following paragraphs, to provide curing
      and to protect concrete surfaces and edges from damage.
   2. Immediately after forms are removed, carefully examine concrete surfaces,
      and repair any irregularities in surfaces and finishes as specified.

B. Form removal:
   1. Do not remove forms from concrete which has been placed when outside
      ambient air temperature is below 50 degrees Fahrenheit until the following
      conditions are satisfied:
      a. Concrete has sufficient strength to allow form removal without damage to
         surfaces.
      b. At least 48 hours have elapsed since the end of concrete placement.
      c. Provisions are in place to maintain moisture for curing concrete, and
         temperature at or above the required minimum curing temperature
         specified.
   2. Vertical forms:
      a. Retain in place for a minimum of 24 hours after concrete is placed.
      b. If concrete has sufficient strength and hardness to resist surface or other
         damage after 24 hours, forms may be removed.
   3. Other forms supporting concrete, and shoring: Retain in place as follows:
      a. Formed sides of footings: 24 hours minimum.
      b. Formed vertical sides of beams, girders, and similar members: 48 hours
         minimum.
      c. Forms below slabs, beams, and girders: Until concrete strength reaches
         specified strength f'_c or until shoring is installed.
         1) Shoring for slabs, beams, and girders: Shore until concrete strength
            reaches minimum specified 28-day compressive strength.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and
   repair any irregularities in surfaces and finishes as specified in Section 03_30_00
   - Cast-in-Place Concrete.

B. Form ties: Remove form ties from surfaces. Fill tie holes as follows:
   1. Remove form ties from surfaces.
   2. Roughen cone shaped tie holes by heavy sandblasting before repair.
   3. Dry pack cone shaped tie holes with dry-pack mortar as specified in
      Section 03_60_00 - Grouting.
   4. Taper ties:
      a. After forms and taper ties are removed from wall, plug tie holes with
         neoprene plug as follows:
         1) Heavy sandblast and then clean tie holes.
2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
3) Locate steel rod in cylindrical recess and against middle of plug during driving.
   a) At no time are plugs to be driven on flat area outside cylindrical recess.
   b) Dry-pack of taper tie holes:
      1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03_60_00 - Grouting.
         a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
         b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
         c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
            (1) Cover with minimum of 10 mils of epoxy gel.
            (2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.
            (3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 TOLERANCES:

A. Finished concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct work within the tolerances in accordance with ACI 117, except as modified in the following paragraph
   or as determined by delegated design professional.
   1. General:
      a. At certain locations in the Work, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements of this Section.
      b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.
   2. Slabs:
      a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
      b. Slabs indicated to be level: Have maximum vertical deviation of 1/8-inch in 10-foot horizontal length without any apparent changes in grade.
   3. Circular tank walls:
      a. The Contractor may deviate from finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.
   4. Inserts and embedments:
      a. Set inserts and embedments to tolerances required for proper installation and operation of equipment or systems to which insert pertains.
      b. Maximum tolerances: As follows:
<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeves and inserts</td>
<td>Plus 1/8 Minus 1/8 inches.</td>
</tr>
<tr>
<td>Anchor bolts:</td>
<td></td>
</tr>
<tr>
<td>Projected ends</td>
<td>Plus 1/4 Minus 0.0 inches.</td>
</tr>
<tr>
<td>Axial alignment</td>
<td>Not more than 2 degrees off the axis indicated on the Drawings.</td>
</tr>
<tr>
<td>Setting location</td>
<td>Plus 1/16 Minus 1/16 inches.</td>
</tr>
<tr>
<td>All embedments</td>
<td>Minimum 1 inch clearance from reinforcing steel.</td>
</tr>
</tbody>
</table>

c. Securing embedded items in formwork by wiring or welding to reinforcement is not permitted.

C. Remove and replace work that does not conform to required tolerances. Procedures and products employed in and resulting from such re-work shall be acceptable to the Engineer.

END OF SECTION
SECTION 03_15_00

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.02 REFERENCES

A. ASTM International (ASTM):

B. American National Standards Institute (ANSI):
   1. A135.4 - Basic Hardboard.

C. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.
C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of Engineer.
   2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
   1. Use specific type in applications as determined by delegated design professional.
   2. Do not use scrap or recycled materials to manufacture joint fillers.
B. Expanded polystyrene joint filler:
   1. Commercially available polystyrene board:
   2. Minimum flexural strength: 35 pounds per square inch in accordance with
      ASTM C203.
   3. Compressive yield strength: Between 16 and 40 pounds per square inch at 5-
      percent compression.

C. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width as determined by delegated
            design professional.
         2) Asphalt-impregnated fiber in accordance with ASTM D1751.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Fibre Expansion Joint.
   2. Synthetic sponge rubber expansion joint material:
      a. Properties:
         1) Thickness: As recommended for width
         2) as determined by delegated design professional.
         3) Material in accordance with ASTM D1752, Type I.
      b. Manufacturers: One of the following or equal:
         1) Williams Products Inc., Everlastic 1300.
         2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing
      the plasticizers, resins, stabilizers, and other materials necessary to meet the
      requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corp.
      b. Sika Corp., Greenstreak PVC Waterstop.
   3. Type: Ribbed waterstop:
      b. Expansion joint for wall penetrations for concrete encased electrical duct
         banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed
      e. No scrap or reclaimed material shall be used.
   4. Properties as indicated in the following table:

<table>
<thead>
<tr>
<th>Physical Characteristics</th>
<th>Test Method</th>
<th>Required Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>ASTM D792</td>
<td>Not less than 1.3.</td>
</tr>
<tr>
<td>Hardness</td>
<td>ASTM D2240</td>
<td>70 to 90 Type A15 Shore durometer.</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D638</td>
<td>Not less than 2,000 pounds per square inch.</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
<td>ASTM D638</td>
<td>Not less than 300 percent.</td>
</tr>
<tr>
<td>Physical Characteristics</td>
<td>Test Method</td>
<td>Required Results</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Alkali Extraction</td>
<td>CRD-C-572</td>
<td>Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.</td>
</tr>
<tr>
<td>Low Temperature Brittle Point</td>
<td>ASTM D746</td>
<td>No sign of cracking or chipping at -35 degrees Fahrenheit.</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D570</td>
<td>Not more than 0.15 percent after 24 hours.</td>
</tr>
<tr>
<td>Accelerated Extraction Test</td>
<td>CRD-C-572</td>
<td>Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.</td>
</tr>
<tr>
<td>Stiffness in Flexure</td>
<td>ASTM D747</td>
<td>Not less than 600 pounds per square inch.</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D624</td>
<td>Not less than 225 pounds per inch.</td>
</tr>
<tr>
<td>Thickness</td>
<td>-</td>
<td>3/8 inch.</td>
</tr>
<tr>
<td>Center Bulb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-inch Waterstops</td>
<td>-</td>
<td>7/8 inch or 1-inch nominal outside diameter.</td>
</tr>
<tr>
<td>9-inch Waterstops</td>
<td>-</td>
<td>For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.</td>
</tr>
<tr>
<td>Allowable Tolerances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>-</td>
<td>Plus or minus 3/16 inch.</td>
</tr>
<tr>
<td>Thickness</td>
<td>-</td>
<td>Plus or minus 1/32 inch.</td>
</tr>
</tbody>
</table>

2.03 JOINT DOWELS

A. Expansion joint dowels:
1. Smooth, un-deformed steel bars conforming to ASTM A615, Grade 60.
2. Provide dowels straight and clean, free of loose flaky rust and loose scale.
3. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inches on the diameter of the dowel and extends no more than 0.04 from the end.
4. Expansion end of the dowel:
   a. Coat bars with a bond breaker.
   b. Provide expansion dowel caps.
B. Slip dowel plastic sleeves: Manufactured using polypropylene:
   1. Manufacturers: The following or equal:
      a. Sika Corp., speed dowel.

C. Slip dowel end caps:
   1. Manufacturers: One of the following or equal:

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
   1. General:
      a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints where indicated on the Drawings prepared by delegated design professional.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings prepared by delegated design professional or not.
      e. Provide waterstops that are continuous.
      f. Set waterstops accurately to position and line as indicated on the Drawings prepared by delegated design professional.
      g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
      h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
      i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
      j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
      k. Special clips may be used in lieu of wires, at Contractor's option.
      l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings prepared by delegated design professional.
      m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
      n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.

2. Polyvinyl chloride waterstop:
   a. Install waterstops so that joints are watertight.
b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
   1) Do not damage material by heat sealing.
   2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
   3) Maintain continuity of waterstop ribs and tubular center axis.
   4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.

   c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.

   d. Prefabricate waterstop joints involving more than 2 butt ends to be joined together, including all joints that involve an angle cut, alignment change, or joining of 2 dissimilar waterstop sections, prior to placement in form.
      1) Provide not less than 24-inch long strips of waterstop material beyond joint.
      2) After inspection and acceptance, install such prefabricated waterstop joint assemblies in forms and butt-weld ends of 24-inch strips to straight run portions of waterstop in place in forms.

   e. Manufacturer shall factory prefabricate joints for crosses and tees.

   f. Split-type waterstops will not be permitted

B. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings prepared by delegated design professional.
   2. Preformed expansion joint material. Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

C. Expanded polystyrene joint filler:
   1. When filler is indicated on the Drawings or specified, place filler in correct position before concrete is placed against filler.
   2. Fill holes and joints in filler with caulking to prevent entry of mortar into joint or passage of mortar or concrete from one side of joint to other.

D. Slip dowels at expansion joints:
   1. Where indicated on the Drawings prepared by delegated design professional, install smooth dowels at right angles to expansion joints.
      a. Align dowels with finished surface.
      b. Rigidly hold in place and support during concrete placement.
   2. Slip dowel sleeves:
      a. Locate slip dowel sleeves on expansion joints as indicated on the Drawings prepared by delegated design professional.
   3. Slip dowel end caps:
      a. Unless otherwise indicated on the Drawings prepared by delegated design professional, apply a bond breaker at one end of dowels through expansion joints.
      b. Provide slip dowel end caps on the lubricated end of expansion dowels.

END OF SECTION
SECTION 03_20_00
CONCRETE REINFORCING

PART 1  GENERAL

1.01  SUMMARY

A.  Section includes:
   1.  Reinforcing bars for delegated design of Truck Sump Pit as specified in
       Section 01_35_73 Delegated Design Procedures and as indicated on the
       drawings 00GS02 and the details provided on GS.
   2.  Reinforcing bars for Main Entrance Sign.
   3.  Miscellaneous steel reinforcing for concrete pads and structural details as
       indicated on the drawings.
   4.  Reinforcing bars for roadways shall be as specified in Section 32_13_13
       Concrete Paving.
       a.  Carbon steel.
   5.  Thread bars.
   7.  Tie wires.

1.02  REFERENCES

   A.  American Concrete Institute (ACI):
       1.  318 - Building Code Requirements for Structural Concrete and Commentary.

   B.  American Iron and Steel Institute (AISI).

   C.  American Welding Society (AWS):
       1.  D1.4 - Structural Welding Code - Reinforcing Steel.

   D.  ASTM International (ASTM):
           Heading and Cold Forging.
       2.  A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for
           Concrete Reinforcement.

   E.  Concrete Reinforcing Steel Institute (CRSI):

1.03  DEFINITIONS

A.  Architectural Concrete: Concrete surfaces that will be exposed to view in the
     finished work.
     1.  Additionally, for purposes of this Section, includes:
        a.  Concrete surfaces that are designated to receive paints or coatings.
        b.  Exposed concrete in open basins, channels, and similar liquid containing
            structures; Surfaces shall be considered exposed to view if located above
a line 2 feet below the normal operating water surface elevation in that structure.

B. Bars: Reinforcement or reinforcing bars as specified in this Section.

C. Evaluation Report: Report prepared by ICC-ES, or by other testing agency acceptable to the Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and its acceptance for use under the Building Code specified in Section 01_41_00 - Regulatory Requirements.

D. Give Away Bars: Reinforcing bars that are not required by the Contract Documents, but are installed by the Contractor to provide support for the required reinforcing bars.

E. Wire Supports: Metal reinforcing supports constructed of steel wire as specified. Includes individual high chairs, continuous high chairs, bolsters and other similar configurations and shapes.

1.04 SUBMITTALS

A. General:
   1. Submit in accordance with Section 01_33_00 - Submittal Procedures.
   2. Submit drawings of rebar for review by delegated design professional and Engineer. Engineer's review will consist of confirming the accuracy of the shop drawings with respect to the design calculations and reference drawings provided by the delegated design professional.

B. Product data:
   1. Bar supports:
      a. Wire bar supports:
         1) Schedule of support materials to be provided and locations of use.

C. Shop drawings:
   1. Reinforcement shop drawings:
      a. Submit drawings showing bending and placement of reinforcement required by the Contract Documents.
      b. Clearly indicate structures or portions of structures covered by each submittal.
      d. Use the same bar identification marks on bending detail drawings, placement drawings, and shipping tags.
      e. Submittals consisting solely of reinforcing bar schedules, without accompanying placement drawings, will not be accepted unless accepted under prior written agreement with Engineer.
   2. Reinforcement placement drawings:
      a. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
      b. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
c. Show anchor bolt locations based on anchor bolt templates for approved equipment.

d. Show splice locations.

3. Reinforcement fabrication drawings:

   a. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations. Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

D. Samples (when requested by Engineer):

   1. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.

   2. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

E. Test reports:

   1. Certified copy of mill test for each steel used. Show physical properties and chemical analysis.

      a. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.

      b. In such cases, submit certificates under the shop drawing submittal number with the letter "R" (for record date) appended to the end (e.g., of the reinforcement was submitted as 03_20_00-002-1, deliver the associated mill certificate as submittal 03_20_00-002-1R).

      c. (s) of steel incorporated into the materials shipped.

F. Special procedures:

   1. Welding procedures conforming to AWS D1.4 for reinforcement to be field welded.

      a. Procedures qualification record.

G. Qualifications statements:

   1. Welder qualifications.

H. Closeout documents:

   1. Field quality control and inspection reports.

   2. Field quality assurance special inspection and testing reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:

   1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks with letter containing manufacturer’s guarantee of grade.
1.06 SEQUENCING AND SCHEDULING

A. Bar supports:
   1. Do not place concrete until samples and product data for bar supports have been accepted by Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. The drawings contain notes describing the size and spacing of reinforcement and its placement, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete, and other related information.

2.02 MATERIALS

A. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.
   2. Reinforcing bars:
      a. ASTM A615 Grade 60 deformed bars, including the following requirements,
         1) Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
         2) Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
   3. Reinforcing bars designated or required to be welded:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.

B. Bar supports:
   1. Wire supports:
      a. All stainless steel bar supports:
         1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire conforming to ASTM A493, AISI Type 316.
      b. Stainless steel protected bar supports:
         1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from cold-drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.
         2) Stainless steel wire ends shall conform to ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.
      c. Bright basic wire bar supports.
   2. Plastic supports:
      a. Manufacturers: The following or equal:
         1) Aztec Concrete Accessories.
3. Deformed steel reinforcing bar supports:
a. Fabricated of materials and to CRSI details recommended for typical
   reinforcement embedded in concrete and bent to dimensions required to
   provide specified clearances and concrete cover.
4. Precast concrete bar supports ("dobies"):
a. Pre-manufactured, precast concrete blocks with cast-in annealed steel
   wires, 16-gauge or heavier.
b. Compression strength of concrete: Equal to or exceeding the compression
   strength of the surrounding concrete.
c. Block dimensions:
   1) Height to provide specified concrete cover.
   2) Footprint not less than 3 inches by 3 inches, and adequate to support
      the weight of the reinforcement and maintain specified concrete
      cover without settling into the underlying surface.

C. Tie wires:
   1. General use: Black annealed steel wire, 16-gauge or heavier.

2.03 FABRICATION

A. Shop fabrication and assembly:
   1. Cut and bend bars in accordance with provisions of ACI 318 and the CRSI
   2. Bend bars cold. Use bending collars to develop the recommended bend
      radius.
   3. Provide bars free from defects and kinks and from bends not required by
      delegated design professional
   4. Circumferential and radiused reinforcement: Roll to the radius required for its
      location in the structure before installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Reinforcing bars and welded wire reinforcement:
      a. Verify that reinforcement is new stock, free from rust scale, loose mill
         scale, excessive rust, dirt, oil, and other coatings that will adversely affect
         bonding capacity when placed in the Work.
   2. Welded wire fabric:
      a. Verify that sheets are not curled or kinked before or after installation.

3.02 PREPARATION

A. Surface preparation:
   1. Reinforcing bars - uncoated:
      a. Clean reinforcement of concrete, dirt, oil and other coatings that will
         adversely affect bond before embedding bars in subsequent concrete
         placements.
      b. Thin coating of red rust resulting from short exposure will not be
         considered objectionable. Thoroughly clean bars having rust scale, loose
         mill scale, or thick rust coat.
c. Partially embedded reinforcement: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placements.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Field-cutting of reinforcing bars is not permitted.
   2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements specified by the delegated design professional. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.

<table>
<thead>
<tr>
<th>Member</th>
<th>Tolerance on Reinforcement Location (1)</th>
<th>Tolerance on Minimum Concrete Cover (1,2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slabs, beams, walls and columns except as noted below:</td>
<td>± 3/8 inch</td>
<td>- 3/8 inch</td>
</tr>
<tr>
<td>10 inches thick and less</td>
<td>± 1/2 inch</td>
<td>- 1/2 inch</td>
</tr>
<tr>
<td>More than 10 inches thick</td>
<td>As noted above</td>
<td>- 1/4 inch</td>
</tr>
<tr>
<td>Formed soffits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal location of bends and ends of reinforcement:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditions not listed below:</td>
<td>± 2 inches</td>
<td>- 1/2 inch</td>
</tr>
<tr>
<td>At discontinuous ends of brackets and corbels</td>
<td>± 1/2 inch</td>
<td>- 1/4 inch</td>
</tr>
<tr>
<td>At discontinuous ends of other members:</td>
<td>± 1 inch</td>
<td>- 1/2 inch</td>
</tr>
</tbody>
</table>

Notes:
(1) ± indicates "plus or minus;" - indicates "minus;" + indicates "plus."
(2) Tolerance on cover is limited as noted, but decrease in cover shall not exceed one third of the minimum cover specified by the delegated design professional.

3. Spacing between bars:
   a. Minimum clear spacing between bars in a layer:
      1) As specified by the delegated design professional, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
   b. Minimum clear spacing between bars in 2 or more parallel layers:
      1) Place bars in upper layers directly above bars in lower layers.
      2) Minimum spacing between layers: As specified by the delegated design professional, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.

4. Lap splices for bars:
   a. Lap splice locations and lap splice lengths: as specified by the delegated design professional. Where lap lengths are not indicated, provide in accordance with ACI 318.
   b. Unless otherwise specifically specified by the delegated design professional (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.
   c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length specified by the delegated design professional.
   d. Stagger lap splices where indicated on the Drawings.
   e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
   1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces.
      a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
   2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.
   3. Do not use "give away bars" that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for give away bars.
   4. Provide bar supports of height required to maintain the clear concrete cover lap splice lengths in accordance with ACI 318.
   5. Provide bar supports at formed vertical faces to maintain the clear concrete cover lap splice lengths in accordance with ACI 318.
   6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

<table>
<thead>
<tr>
<th>Case</th>
<th>Location</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Concrete placed over earth and concrete seal slabs (&quot;mud mats&quot;):</td>
<td>Precast concrete bar supports</td>
</tr>
<tr>
<td>b.</td>
<td>Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings):</td>
<td>All stainless steel bar supports.</td>
</tr>
<tr>
<td>c.</td>
<td>Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work</td>
<td>Stainless steel protected bar supports.</td>
</tr>
</tbody>
</table>
### Table 2 - Reinforcement Support Materials

<table>
<thead>
<tr>
<th>Case</th>
<th>Location</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>d.</td>
<td>Concrete placed against forms and exposed to interior equipment/piping areas in the finished work</td>
<td>Stainless steel protected bars supports.</td>
</tr>
<tr>
<td>e.</td>
<td>Between mats of reinforcement, and fully embedded within a concrete member</td>
<td>Bright basic wire bars supports, or deformed steel reinforcing bars.</td>
</tr>
</tbody>
</table>

D. **Tying of reinforcing:**

1. Fasten reinforcement securely in place with wire ties.
2. Tie reinforcement at spacings sufficient to prevent shifting.
   a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
3. Tie slab bars at every intersection around perimeter of slab.
4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

<table>
<thead>
<tr>
<th>Table 3 - Maximum Spacing of Tie Wires for Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bar Size</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Bars Number 5 and Smaller</td>
</tr>
<tr>
<td>Bars Number 6 through Number 9</td>
</tr>
<tr>
<td>Bars Number 10 and Number 11</td>
</tr>
</tbody>
</table>

5. After tying:
   a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.
   b. Remove tie wire clippings from inside forms before placing concrete.

E. **Welding reinforcing bars:**

1. Weld reinforcing bars only where where acceptance is received from Engineer prior to welding.
2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by Engineer.
   a. Conform to requirements for minimum preheat and interpass temperatures.
3. Submit:
   a. Welding procedures specification.
   b. Procedures qualification record.
   c. Welder qualification test record.
4. Do not tack weld reinforcing bars except where specifically determined by delegated design professional.

### 3.04 Field Quality Control

A. Provide quality control for the Work of this Section as specified in Section 01_45_00 - Quality Control.
B. Field inspections and testing:
   1. Submit records of inspections and testing to Engineer in electronic format within 24 hours after completion.

3.05 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01_45_00 - Quality Control.

B. Special inspections and tests:
   1. Delegated design professional specified in Section 01_35_73 Delegated Design Procedures shall be responsible to provide all special tests and inspections required by the referenced codes for quality assurance of the construction of the delegated design.
   2. Frequency of inspections:
      a. Delegated design professional specified in Section 01_35_73 Delegated Design Procedures shall be responsible to provide periodic special inspection as required by the Building Code specified in Section 01_35_73.
   3. Preparation:
      a. Review Drawings and Specification for the Work to be observed.
      b. Review approved submittal shop drawings.
   4. Inspections: Special inspection shall include, but is not limited to, the following items.
      a. Reinforcement: General:
         1) Type (material) and location of reinforcement supports.
         2) Bar material/steel grade and bar size.
         3) Location, placement, and spacing of bars.
         4) Clear concrete cover over reinforcement.
         5) Lap splice: Location and lap length. Bars within tolerances for contact (unless non-contact splice is indicated on the Drawings provided by the Delegated Design Professional.)
         6) Bar hooks and development lengths embedded within concrete sections as indicated on the Drawings provided by the Delegated Design Professional.
         7) Reinforcement tired in position and tie wire legs turned inward toward the center of the concrete section.
      b. Reinforcement: Welding:
         1) Inspector qualification and inspections shall be in accordance with the requirements of AWS D1.4.
         2) Provide periodic inspection for:
            a) Weldability of reinforcement other than ASTM A706.
            b) Single pass fillet welds with thickness less than or equal to 5/16 inch.
         3) Provide continuous inspection for:
            a) Other welds.
            b) Welds at mechanical reinforcing bar couplers and end anchors.
         4) In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods, including radiographic inspection.
   5. Records of inspections:
      a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspections.

3.06 NON-CONFORMING WORK

A. Before placing concrete, adjust or remove and re-install reinforcement to conform to the requirements of the Contract Documents.

END OF SECTION
SECTION 03_21_17
ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

A. American Concrete Institute (ACI).
   1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):

C. ASTM international (ASTM):

D. Concrete Reinforcing Steel Institute (CRSI).

E. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. Society for Protective Coatings (SSPC):
   1. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

A. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the Building Code specified in Section 01_41_00 - Regulatory Requirements.

1.04 SUBMITTALS

A. Product data: Technical data for adhesives, including:
   1. Manufacturer's printed installation instructions (MPII).
   2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
   3. Handling and storage instructions.
B. Quality control submittals:
   1. Special inspection: Detailed step-by-step instructions for the special inspection
      procedures required by the building code specified in Section 01_41_00 -
      Regulatory Requirements.
   2. For each adhesive to be used, Evaluation Report confirming that the product
      complies with the requirements of AC308 for both un-cracked and cracked
      concrete and for use in Seismic Design Categories A through F.
   3. Installer qualifications:
      a. Submit evidence of successful completion of adhesive manufacturer's
         installation training program.
      b. Submit evidence of current certification for installation of inclined and
         overhead anchors under sustained tension loading.

C. Inspection and testing reports:
   1. Inspections: Field quality control: Reports of inspections and tests.
      a. Inspections: Field quality assurance: Reports of special inspections and
         tests.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installation requirements:
      a. Have available at the site, and install anchors in accordance with, the
         adhesive manufacturer's printed installation instructions.
   2. Installer qualifications:
      a. Demonstrating successful completion of adhesive manufacturer's on-site
         training program for installation of adhesive-bonded anchors.
      b. Holding current certification for installation of adhesive-bonded anchors by
         a qualified organization acceptable to the Engineer and to the Building
         Official.
      1) Organizations/certification programs deemed to be qualified are:
         a) ACI-CRSI Adhesive Anchor Installer Certification Program.
         b) Adhesive anchor manufacturer's certification program, subject to
            acceptance by the Engineer and the Building Official.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products as follows, unless more restrictive requirements are
   recommended by the manufacturer:
   1. Store adhesives and adhesive components on pallets or shelving in a covered-
      storage area protected from weather.
   2. Control temperature to maintain storage within manufacturer's recommended
      temperature range.
      a. If products have been stored at temperatures outside manufacturer's
         recommended range, test by methods acceptable to the Engineer to
         confirm acceptability before installing in the Work.
   3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

A. Seismic Design Category (SDC) for structures: as indicated on the drawing.
PART 2  PRODUCTS

2.01  GENERAL

A.  Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

B.  Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements of ACI 355.4 and of ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.

C.  Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings provided by Delegated Design Professional specified in Section 01_35_73 Delegated design Procedures or approved in writing by the Engineer.

2.02  EPOXY ADHESIVE

A.  Materials:
   1.  Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   2.  2-component, 100 percent solids, insensitive to moisture.
   3.  Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

B.  Packaging:
   1.  Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer’s static mixing nozzle.
      a.  Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
      b.  Provide nozzle extensions as required to allow full-depth insertion and filling from the bottom of the hole.
   2.  Container markings: Include manufacturer’s name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C.  Manufacturers: One of the following or equal:
   2.  Simpson Strong-Tie Co., Inc., SET-XP.

2.03  ALL THREAD RODS

A.  Materials: 316 Stainless Steel.

2.04  REINFORCING BARS

A.  As specified in Section 03_20_00 - Concrete Reinforcing.
PART 3   EXECUTION

3.01   GENERAL

A.   Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official.
   1.   Do not install holes or adhesive until training is complete.

B.   Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.

C.   Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings provided by the Delegated Design Professional.
   1.   If embedment depth is not indicated, contact Engineer for requirements.

3.02   PREPARATION

A.   Do not begin installation of adhesive bonded anchors until:
   1.   Concrete has achieved an age of at least 21 days after placement.
   2.   On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embed in holes.

B.   Review manufacturer's printed installation instructions (MPII) and "conditions of use" stipulated in the Evaluation Report before beginning work.
   1.   Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents and resolve before proceeding with installation.

C.   Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

D.   Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions, and will remain so during the curing time for the product.

3.03   HOLE SIZING AND INSTALLATION

A.   Drilling holes:
   1.   Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2.   Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by Engineer.
B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
      a. Installation of anchors in cored holes is not permitted.
      b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.
      c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
   2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a "condition of use" in the Evaluation Report.
      a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.

D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings by the delegated Design Professional.

E. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
      a. Obtain Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
      b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
      c. Epoxy grout may be substituted for dry-pack mortar when accepted by Engineer.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
   3. When existing reinforcing steel is encountered during drilling and when specifically accepted by Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
   4. Bent bar reinforcing bars: Where edge distances are critical, and interference with existing reinforcing steel is likely, if acceptable to Engineer, drill hole at 10 degree (or less) angle from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
   1. Insert air nozzle to bottom of hole and blow out loose dust.
      a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
      b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
   a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
   b. Repeat at least 4 times.
3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPIII and the Evaluation Report.
4. Leave prepared holes clean and dry.
5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
   2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
   1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
   2. Fill hole as nozzle is withdrawn without creating air voids.
   3. Fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
   4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods.
   1. Install bars and rods perpendicular to the concrete surface.
   2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer’s recommended procedures.
   3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
   4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
   5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading.
   1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
   2. Do not disturb or load bonded embeds until manufacturer’s recommended cure time, based on temperature of the concrete, has elapsed.
3.05 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
   1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
   2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
   1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
      a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
   2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
   2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Delegated Design Professional Specified in Section 01_35_73 – Delegated Design Procedures shall be responsible to provide the special inspections required for the designs.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
      b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent
installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.

3. Preparation:
   a. Review Drawings and Specifications for the Work to be observed.
   b. Review adhesive manufacturer's MPII and recommended installation procedures.
   c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.

4. Inspection: Periodic:
   a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
      1) Concrete: Class (minimum specified compressive strength) and thickness.
      2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
      3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "conditions of use" listed in the Evaluation Report.
      4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
      5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
   b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
      1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
      2) For ongoing installations, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.

5. Inspection: Continuous.
   a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.

6. Records of inspections:
   a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
   b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION
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**Attachment A - Menzel Formula and Nomograph**

**Attachment B - Coarseness Factor Chart**

**Attachment C - Combined Aggregate Gradation Chart**

**Attachment D - Concrete Placement Checklist**
PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Class A Cast-in-place concrete for Truck Scale Pit structural concrete as indicated on the drawings.

B. The requirements of this Section will require advance planning for preparation and testing of trial batches. Review the mix design and testing requirements carefully, and schedule preparations and testing with sufficient time to complete tests, to obtain Engineer's review of mixes and testing results, and to complete revisions and re-testing if required.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. CODE-318 - Building Code Requirements for Structural Concrete and Commentary.
   2. CODE-350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   3. PRC-212.3 - Report on Chemical Admixtures for Concrete.
   4. PRC-302.1 - Guide to Concrete Floor and Slab Construction.

B. ASTM International (ASTM):
   2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   7. C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   14. C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
24. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).
29. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
31. C856 - Standard Practice for Petrographic Examination of Hardened Concrete.
42. D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

C. National Ready-Mixed Concrete Association (NRMCA).
1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.

1. Alkali: The sum of sodium oxide and potassium oxide calculated as sodium oxide.

2. Alkali Load: Amount of alkalis contributed by the Portland cement in a concrete mixture, expressed in pounds per cubic yard (lb/yd³) and calculated by multiplying the Portland cement content of the concrete in lb/yd³ by the alkali content of the Portland cement divided by 100.

3. Architectural Concrete: Concrete surfaces that will be exposed to view in the finished work.
   a. For purposes of this Section, includes only those surfaces that receive paint or coatings.
   b. Exposed concrete surfaces in open basins, channels, and similar liquid containing structures: Surfaces will be considered exposed to view if located above the water line as defined in Section 03_35_29 - Tool Concrete Finishing.
   c. Exterior concrete surfaces with portions above and below grade: Surface will be considered exposed to view of located above the grade line as defined in Section 03_35_29 - Tool Concrete Finishing.

4. Average Daily Temperature: Calculated by summing hourly measurements of air temperature in the shade at the face of the concrete and dividing that sum by 24. In calculating the sum of the temperatures recorded, any measurement less than 50 degrees Fahrenheit shall be recorded as 0 degrees Fahrenheit and included in the sum.


6. Class of Concrete: Refers to a mix with characteristics, proportions, and constituents (including a specific combination of admixtures) as specified in this Section.
   a. Any change in the source or characteristics of constituent materials, in the proportions of materials, or in the admixtures included in a mix shall be considered as creating a new and separate class of concrete.
   b. Any mix to be placed by pumping shall be considered as creating a new and separate class of concrete.

7. Cold Weather: Includes one or more of the following conditions:
   a. Current air temperature is 45 degrees Fahrenheit and falling.
   b. Air temperature during the first 24 hours after placement is expected to fall into the range of 45 degrees Fahrenheit to 40 degrees Fahrenheit.
   c. A period when, for more than 3 consecutive days, the following conditions exist:
      1) The average daily air temperature drops below 40 degrees Fahrenheit.
      2) The air temperature is not greater than 50 degrees Fahrenheit for more than one-half of any consecutive 24-hour period.


9. Green Concrete: Concrete that has not yet achieved 100 percent of the minimum specified compressive strength, fₖ, for that mix.

10. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch (0.004 inches).
11. Hot Weather: Any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.2 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI PRC-305 and in this Section, Attachment A - Menzel Formula and Nomograph.


13. Paste Content: The total concrete volume minus the volume of aggregate, expressed as a percentage of total volume. Paste volume includes volume of cementitious materials, water, air, admixtures materials, and any fibers.

14. Supplemental Cementitious Material: Inorganic material such as fly ash, natural pozzolans, silica fume, or slag cement that reacts pozzolanically or hydraulically.

1.04 DELEGATED DESIGN

A. Provide Delegated Design for the following Work, based on the requirements of this Section.
   1. Concrete mix designs.

1.05 SUBMITTALS

A. General:
   1. Data for concrete mixes and mix constituents supplied to the Work shall be coordinated through a single supplier.
   2. A maximum of 2 mix designs will be reviewed by the Engineer for each class of concrete required.
      a. Review of additional mix designs shall be at the expense of the Contractor.

B. Product data:
   1. Submit data completely describing products and demonstrating compliance with the requirements of this Section.
   2. Data for all products in the mix for each class of concrete shall be submitted concurrently with that mix design.
   3. Where products conforming to NSF-61 are required, submit evidence of testing and listing under NSF-61 for use in direct contact with potable water. Testing and listing shall be by a nationally recognized agency acceptable to the Engineer.
   4. Admixtures:
      a. For each admixture included in concrete mixes, submit manufacturer's product data demonstrating compliance with standards specified.
      b. If air entraining admixture requires test method other than ASTM C173 to accurately determine air content, make special note of requirements in Submittal.
   5. Curing compound: Submit complete data on proposed compound.

C. Design data:
   1. Concrete mix designs:
      a. Submit full details, including mix design calculations and plots, for concrete mixes proposed for use for each class of concrete.
      b. Include mix design calculations of proportions by both weight and volume.
c. Determine and include the alkali load of the proposed mix.
d. Include information on correction of batching for varying moisture contents of fine aggregate.
e. Submit source quality test records with mix design Submittal.
f. Provide calculations demonstrating that the mixes proposed provide the required average compression strength of concrete (f'c) based on source quality test records.
g. For each Class A mix design submitted, plot the mix design Attachment B - Coarseness Factor Chart and submit.
h. For each Class A mix design submitted, plot the combined aggregate gradation on the chart Attachment C - Combined Aggregate Gradation Chart and submit.

D. Concrete mixes - Trial batches:
   1. Drying shrinkage test results.
      a. Submit results of testing.
   2. Compression strength test results.
      a. Submit results of testing. Provide data for each cylinder tested.
      b. Submit data indicating trial batch mix designator, slump, and specimen number for each test cylinder.
   3. If there is any change in suppliers or in quality of concrete mix constituents, submit new test data.

E. Test reports:
   1. Dated not more than 24 months prior to the date of Submittal.
   2. Aggregate:
      a. Submit certified copies of commercial laboratory tests proposed for use in concrete.
      b. Sieve analyses:
         1) During construction, submit sieve analyses of coarse, fine, and combined aggregates used any time there is a change in supplier, or a significant change in the character and/or grading of materials, and when requested by the Engineer.
      c. Aggregates - coarse:
         1) Physical properties:
            a) Sieve analysis.
            b) Percentage of particles having flat and/or elongated characteristics.
            c) Abrasion loss.
            d) Soundness.
         2) Deleterious substances:
            a) Clay lumps and friable particles content.
            b) Materials finer than 200 sieve (percentage).
            c) Shale and chert content.
            d) Coal and lignite content.
         3) Alkali reactivity.
         4) Deleterious substances:
            a) Clay lumps and friable particles content.
            b) Chert and shale content.
            c) Coal and lignite content.
            d) Materials finer than No. 200 sieve.
      5) Alkali reactivity.
d. Aggregates - Fine:
   1) Physical properties:
      a) Sieve analysis and fineness modulus.
      b) Soundness.
   2) Deleterious substances:
      a) Clay lumps and friable particles (percentage).
      b) Materials finer than No. 200 sieve (percentage).
      c) Coal and lignite (percentage).
      d) Shale and chert.
      e) Organic impurities ("Color" as determined by ASTM C40).
   3) Alkali reactivity.

e. Aggregates - Combined:
   1) Test combined gradation for the following sieve sizes: 1.5 inches, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, Number 4, Number 8, Number 16, Number 30, Number 100, Number 200.
   2) Bulk density in accordance with ASTM C29.
   3) Void content in accordance with ASTM C29.
   4) Submit at:
      a) Initial mixture design Submittal.
      b) Intervals of not more than 4 weeks.
      c) Any time there is a change in character or grading of constituent materials.
      d) When requested by the Engineer.

3. Cement:
   a. Mill tests, including alkali content measured as equivalent alkalies, for each shipment of cement included in the Work.
      1) During construction, submit mill certificates for cement being used at intervals of not more than 90 days, any time there is a change in supplier or a significant change in the character of the materials, and when requested by the Engineer.

4. Supplemental cementitious material:
   a. Fly ash: Identify source and provide testing results to demonstrate compliance with requirements of ASTM C618 and this Section.
      1) Include supplier’s report certifying the total alkali content of the material, expressed as equivalent percentage of sodium oxide (Na₂Oe).

F. Certificates:
   1. Current NRMCA certification for all plants and trucks that will be used to supply concrete.

G. Source quality control Submittals:
   1. Truck batch tickets for each load of concrete delivered to the site, whether accepted or rejected.
   2. Concrete supplier’s quality control plan. Include the following elements, at a minimum:
      a. Names and qualifications of key quality control personnel:
         1) Quality control manager.
         2) Testing and inspection personnel.
b. Names and qualifications of testing laboratories:
   1) Each laboratory shall hold current accreditation from the AASHTO
      Accreditation Program, or other accreditation program acceptable to
      the Engineer, for each test performed.

c. Example forms for: Inspection reports, certificates of compliance, and test
   results.

d. Quality control procedures: Method and frequency of performing each
   procedure, including inspections and materials testing. At a minimum, the
   plan shall include:
   1) Daily testing of aggregate gradation.
   2) Monthly testing of cement quality.
   3) Monthly testing of fly ash quality.

e. Procedures to control quality characteristics, including standard
   procedures to address properties outside the specified operating limits,
   and example reports to document non-conformances and corrective
   actions taken. Include procedure for notifying Contractor and Engineer of
   non-conformances.

f. Procedures for verifying that:
   1) Materials are properly stored during concrete batching operations.
   2) Batch plants have the ability to maintain concrete consistency during
      periods of extreme heat and of low temperatures.
   3) Admixtures are dispensed in the correct dosages within the accuracy
      requirements specified.
   4) Delivery trucks have a valid NRMCA certification card.

g. Procedures for verifying that weighmaster certificate for each load of
   concrete shows:
   1) Cement and supplementary materials are from sources designated in
      the approved Submittals.
   2) Concrete as-batched complies with the constituent weights
      designated in the approved Submittals.
   3) Corrections for aggregate moisture are being correctly applied.
   4) Any mix water withheld from the batch.

h. Procedures for visually inspecting concrete during discharge.

H. Field quality control Submittals:
   2. Contractor's reports of field quality control testing.
      a. Include with each report the concrete batch ticket number and
         identification numbers for associated cylinders used for compressive
         strength testing.
      b. Testing results for slump, temperature, unit weight, and air entrainment.
      c. Testing results for compressive strength at 7 and 28 days, and for any
         compressive strength tests after 28 days.
      d. Note on batch ticket the amount of water that was withheld and the
         maximum amount that can be added on site as “Max add water.” Record
         on the batch ticket the volume of water actually added at site.
      e. Note on the batch ticket the concrete mix classification as defined in
         Table 3 of this Section.
I. Special procedure Submittals:
1. Sequence of concrete placing:
   a. Submit proposed sequence of placing concrete showing proposed
      beginning and ending of individual placements. Submittal shall include
      plans sections and details to address all pours.
2. Cold weather concreting plan.
3. Hot weather concreting plan.
4. Repair of defective concrete: Submit mix design for repair materials to be used.

1.06 QUALITY ASSURANCE

A. Pre-installation meetings:
1. Schedule and conduct pre-installation meeting at least 10 days prior to
   batching and placing of concrete.
   a. Provide additional meetings if necessary, to discuss specific concrete
      Submittals, mixes, or placing and curing conditions.
   b. Notify Engineer of location and time of each conference.
2. Required attendees:
   a. Contractor including Contractor's superintendent and key personnel.
   b. Concrete supplier.
   c. Technical representative(s) of supplier(s) of concrete admixtures.
   d. Subcontractor(s) providing pumping, placing, finishing, and curing.
   e. Subcontractor(s) providing embedded items (structural embedded plates,
      electrical conduit).
   f. Sampling and testing personnel.
   g. Engineer.
   h. On-site inspectors representing Engineer.
   i. Other persons deemed by the Engineer and the Contractor to be critical to
      the quality and efficiency of the Work.
3. Agenda:
   a. Review of requirements of Drawings and Specifications.
   b. Project and product safety requirements.
   c. Discussion of points of interface and coordination between various trades
      or products to be used in the Work.
   d. Contractor's schedule for cast-in-place concrete work.
   e. Mix designs, mix tests, and Submittals.
   f. Admixture types, dosing, performance, requirements for monitoring, and
      limits on dosing or re-dosing at the site.
   g. Placement and consolidation methods, techniques, and equipment and
      the effects of those methods on form pressures.
   h. Slump and limits on placing time or conditions to maintain placeability.
      1) Field adjustment of slump and air content.
   i. Procedures for finishing, curing, and retention of moisture during these
      operations.
   j. Procedures and protection for hot and cold weather conditions.
   k. Requirements and coordination for inspections.
      1) Responsibility for test specimen curing and storage.
      2) Distribution of test reports.
   l. Other Specification requirements requiring coordination between parties
      to the work.
4. Prepare and submit minutes of the pre-installation meeting
1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in manner that prevents damage
      and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in
      moisture content will not interfere with steady production of concrete of
      specified degree of uniformity and slump.

B. Acceptance at site:
   1. Reject material containers or materials showing evidence of water or other
      damage.
   2. Concrete mixes: Do not accept or incorporate into the Work concrete mixes
      that do not comply with the specified requirements for water content, slump,
      temperature, and air content.

1.08 PROJECT CONDITIONS

A. Cold weather concreting: During periods of cold weather as defined in this Section,
   implement cold weather concreting procedures in this Section.

B. Hot weather concreting: During periods of hot weather as defined in this Section,
   implement hot weather concreting procedures in this Section.

1.09 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in a manner that completes all placing operations from
   one construction, contraction, or expansion joint to another construction,
   contraction, or expansion joint.

B. Joints at each end of the placement shall be as indicated on the Drawings, or as
   identified and accepted in advance by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. It is the intent of this Section to secure, for every part of the Work, concrete with a
   homogeneous mixture, that, when hardened, will have required strength,
   watertightness, and durability.

B. It is the intent of this Section to procure a workable, low-shrinkage concrete mix that
   maximizes aggregate content and minimizes paste content.

C. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of Portland
         cement supplemental cementitious materials, aggregate, admixtures and
         water, proportioned and mixed to produce a plastic, workable mixture in
         accordance with requirements of this Section, and suitable to specific
         conditions of placement.
b. Proportion aggregates to produce an gradation of aggregate that combines fine and coarse aggregate in well-graded proportions that maximizes the aggregate content and minimizes the paste content of the mix. The gradation should maximize long-term durability and strength of the concrete mixture.

c. Durability requirements will be deemed to be satisfied when:
   1) The mixture is proportioned with a well-graded combined aggregate.
   2) The specified water-cement ratio is satisfied.
   3) The concrete contains the specified range of air content.
   4) The maximum specified paste content is satisfied.

d. Proportion materials in a manner that will secure the lowest cement content, water-cementious materials ratio, and paste volume that is consistent with good workability that provides a plastic and cohesive mixture, and that provides a slump that is within the specified range.

e. Construction and expansion joints will be positioned in structures in accordance with the delegated design, and curing methods have been specified, for purpose of to reduce the number and size of cracks, resulting from normal expansion and contraction expected from the concrete mixes specified.

f. Remove and replace, or repair as specified in this Section, non-conforming work and surfaces with cracks, voids and honeycombs, or surface wetness.


2.02 MATERIALS - GENERAL

A. Water and ice:
   1. Water for concrete mixes, for washing aggregate, and for curing concrete:
      Clean and free from oil and deleterious amounts of alkali, acid, organic matter,
      or other substances from a municipal potable water source.
   2. Do not use water from concrete production operations, or combined water from concrete production operations as defined in ASTM C1602.

2.03 MATERIALS - CONCRETE MIX CONSTITUENTS

A. Water and ice:
   1. As specified in the preceding paragraphs.

B. Cementitious materials:
   1. Portland cement:
      a. In accordance with ASTM C150.
         1) Type II
      b. Single source: To provide uniformity of appearance, for each structure use only one source, type, and brand of Portland cement for walls and slabs that will be exposed in the finished work.
         1) Confirm adequate supply of cement over duration of project before making trial batches or beginning concrete placements.
      c. Cement for finishing: Provide cement from same source and of same type as concrete to be finished or repaired.
C. Supplementary cementitious materials:
   1. Fly ash:
      a. Class C or Class F fly ash in accordance with the requirements of ASTM
         C618, except as modified in this Section.
         1) Class C may be used in concrete made with Type II Portland cement.
         2) Class F required if used in concrete mixes containing aggregates
            classified as potentially reactive based on ASTM C1293 or
            ASTM C1260.
            a) CaO content: Less than 18 percent.
      b. Loss on ignition: Not exceeding 3 percent.
      c. Replace Portland cement at ratio of 1.0 pound fly ash for each pound of
         cement, up to minimum and maximum replacement as specified in
         “Requirements for Mix Proportioning.”

D. Admixtures:
   1. General:
      a. Do not include admixtures, other than those specified, unless written
         acceptance has been obtained from the Engineer during Submittal of mix
         designs.
      b. Admixtures shall be compatible with concrete constituents and with other
         admixtures.
         1) All admixtures in a given mix shall be products of the same
            manufacturer to ensure compatibility.
         2) Admixture manufacturers: One of the following, or equal.
            a) Master Builders Solutions.
            b) Euclid Chemical.
            c) GCP Applied Technologies (formerly W.R. Grace).
            d) Sika Corp.
      c. Do not use admixtures containing chlorides, calculated as chloride ion, in
         excess of 0.5 percent by weight of cement.
      d. Use in accordance with manufacturer’s recommendations. Add each
         admixture to concrete mix separately.
      e. Admixtures used shall be the same products used in concrete trial
         batches, or the same products used in concrete represented by submitted
         field test records.
   2. Air entraining admixture (AEA):
      a. In accordance with ASTM C260 and dosed to provide entrained air
         percentages specified in this Section.
      b. Provides entrained air as bubbles, evenly dispersed at the time of
         placement and during curing.
   3. Water reducing admixture (WRA):
      a. May be used at the Contractor’s option.
      b. Conforming to ASTM C494, Type A (water-reducing).
         1) ASTM C494, Type D (water-reducing and retarding) may be used
            during periods of hot weather with prior acceptance by the Engineer.
      c. Not containing air-entraining agents.
      d. Liquid form before adding to the concrete mix.
   4. High range water reducing admixtures ("super-plasticizers") (HRWR):
      a. Not permitted without acceptance by Delegated design professional and
         Engineer.
5. High-range, water-reducing admixture ("superplasticizer") (HRWR):
   a. In accordance with ASTM C494, Type F (high-range, water-reducing).
      1) ASTM C494, Type G (high-range, water-reducing and retardirng) may be used during periods of hot weather with prior acceptance by the delegated design professional and Engineer.
   b. Producing non-segregating, plasticized concrete with little bleeding and the physical characteristics of low water/cement ratio concrete.
   c. Admixture shall maintain treated concrete in a plasticized state for not less than 1 hour.

6. Shrinkage reducing admixture (SRA):
   a. May be used at Contractor's option.
      1) Provide shrinkage reducing admixture in sufficient dosage so as to produce shrinkage within the limits specified.
   b. Not containing expansive agents.
   c. In accordance with ASTM C494, Type S (specific performance).
   d. One of the following, or equal:
      1) Master Builders Solutions: SRA Series.
      2) Euclid Chemical: Eucon SRA Series.
      3) GCP Applied Technologies: Eclipse Series.

7. Set-controlling admixtures:
   a. Shall not be used without prior acceptance from Engineer.

E. Coloring admixtures:
   1. Conduit encasement coloring agent:
      a. Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
      b. Manufacturers: One of the following or equal:
         1) Davis Co., #100 Utility Red.
         2) L. Reiss Co., Inc., equivalent product.
         3) Euclid Chemical Co., Increte Division, "Colorcrete Brick Red".
      c. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

F. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
      b. Provide aggregates to produce in place concrete with unit weight as follows:
         1) Normal weight concrete: Not less than 140 pounds per cubic foot.
      c. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
      d. Do not use aggregate recycled from fresh concrete returned to the batching facility.
   2. Alkali-silica reactivity:
      a. Provide aggregate classified as aggregate-reactivity class of R0 in accordance with ASTM C1778 with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260, and not greater than 0.04 percent at 1 year when tested in accordance with ASTM C1293.
3. Fine aggregate:
   a. Material graded such that 95 to 100 percent of material passes the No. 4 (4.75 mm) sieve, when sampled in accordance with ASTM D75 and D3665, and tested in accordance with ASTM C136.
   b. Provide fine aggregate consisting of clean, natural sand, or sand prepared from crushed stone or crushed gravel.
   c. In accordance with ASTM C33 requirements for grading, deleterious substances, soundness, and alkali reactivity, except as modified in the following paragraphs:
      1) Grading: For sieve sizes listed in ASTM C33 for fine aggregate, not more than 45 percent passing any sieve and retained on the next consecutive sieve.
      2) Deleterious substances: Not in excess of the percentages by weight specified in Table 1 of this Section.

<table>
<thead>
<tr>
<th>Item</th>
<th>Test Method</th>
<th>Percent (maximum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials finer than No. 200 sieve(2)</td>
<td>ASTM C117</td>
<td>3.00(2)</td>
</tr>
<tr>
<td>Clay lumps and friable particles</td>
<td>ASTM C142</td>
<td>1.00</td>
</tr>
<tr>
<td>Lightweight particles (SG &lt; 2.40)</td>
<td>ASTM C123</td>
<td>1.00</td>
</tr>
<tr>
<td>• Chert or shale(1)</td>
<td>ASTM C295</td>
<td>1.00(1)</td>
</tr>
<tr>
<td>Coal and lignite</td>
<td>ASTM C123</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Notes:
(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage of lightweight particles (sum of shale, chert, coal and lignite) not greater than 1.00, testing under ASTM C295 will not be required.
(2) For manufactured sand, if material finer than the No. 200 sieve consists of crusher dust and the aggregate is essentially free of clay or shale, maximum percentage may be increased to 5.0 percent.

3) Organic impurities: Free of injurious amounts of organic matter and producing a supernatant liquid with color not darker than "standard color" when tested in accordance with ASTM C40.
4) Soundness: In accordance with requirements of ASTM C33 when tested in accordance with ASTM C88 using sodium sulfite solution.

4. Coarse aggregate:
   a. Materials graded such that not more than 10 percent of material passes the 3/8-inch sieve, when sampled in accordance with ASTM D75 and D3665, and tested in accordance with ASTM C136.
   b. Consisting of gravel, crushed gravel, crushed stone, or a combination of these materials having clean, hard, durable particles free from calcareous coatings, organic matter, or other deleterious substances.
   c. Conforming to the requirements of ASTM C33, Class 4S for physical properties, deleterious substances, and alkali reactivity, except as modified in the following paragraphs:
      1) Grading:
         a) Size number as specified in ASTM C33, and as indicated in Table 3 of this Section, except as otherwise specified or accepted by the Engineer.
         b) Weights of flat or elongated particles (particles having a length greater than 3 times average width or thickness) not exceeding 15 percent when tested in accordance with ASTM D4791.
2) Deleterious substances: Not in excess of the percentages by weight specified in Table 2 of this Section and having total of all deleterious substances exceeding 2 percent.

<table>
<thead>
<tr>
<th>Item</th>
<th>Test Method</th>
<th>Percent (maximum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps and friable particles</td>
<td>ASTM C142</td>
<td>0.50</td>
</tr>
<tr>
<td>Lightweight particles (SG &lt; 2.40)</td>
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<td>1.25</td>
</tr>
<tr>
<td>• Chert or shale(1)</td>
<td>ASTM C295</td>
<td>1.00(1)</td>
</tr>
<tr>
<td>Materials finer than No. 200 sieve</td>
<td>ASTM C117</td>
<td>0.50(2)</td>
</tr>
<tr>
<td>Coal and lignite</td>
<td>ASTM C123</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Notes:
1. ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, coal and lignite. If testing under ASTM C123 indicates a combined percentage (sum of shale, chert, coal and lignite) not greater than 1.25, testing under ASTM C295 will not be required.
2. When material finer than No. 200 sieve consists of crusher dust, maximum percentage may be increased to 1.00 percent. When mix design complies with provisions of ASTM C33, Table 4, footnote C, the maximum percentage may be increased in accordance with the equation in footnote C, up to a maximum of 1.5 percent.

3) Abrasion loss: Loss not greater than 45 percent after 500 revolutions when tested in accordance with ASTM C131.
4) Soundness: Loss not greater than 10 percent when tested in accordance with ASTM C88 using sodium sulfate solution.

2.04 MATERIALS FOR PLACING, CURING AND FINISHING

A. General:
   1. Materials shall be compatible with concrete and with other materials.

B. Cement grout:
   1. Use: For spreading over surface of construction and cold joints in concrete before placing additional concrete above those joints.
   2. As specified in Section 03_60_00 - Grouting.

C. Concrete sealer:
   1. As specified in Section 03_35_29 - Tooled Concrete Finishing.

D. Evaporation retardant:
   1. Use: For mitigating surface moisture evaporation from freshly placed concrete during rapid drying conditions. Placed after screeding.
   2. Waterborne, monomolecular, spray-applied compound, with fugitive dye to indicate coverage.
   3. Manufacturers: One of the following or equal:
      a. Master Builders Solutions, MasterKure ER 50.
      b. Euclid Chemical Co., Eucobar.
E. Non-slip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is,
      homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or
      cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Co.
      b. Abrasive Materials, Inc.
      c. “Non-Slip Aggregate”, Euclid Chemical Co.

F. Plastic membrane for curing:
   1. Polyethylene film: In accordance with ASTM C171.
   2. Properties:
      b. Thickness: Nominal thickness of polyethylene film shall not be less than
         0.0040 inches when measured in accordance with ASTM D2103.
         Thickness of polyethylene film at any point shall not be less than
         0.0030 inches.
      c. Loss of moisture: Not exceed 0.055 grams per square centimeter of
         surface when tested in accordance with ASTM C156.

G. Sprayed membrane curing compound:
   1. Combination curing and sealing products (“cure and seal”) will not be
      permitted.
   2. Properties:
      a. Clear type with fugitive dye conforming with ASTM C309, Type 1D and
         containing no wax, paraffin, or oils.
      b. For concrete placed or cured during hot weather, curing compound shall
         be as specified, except that:
            1) It shall include a white, reflective fugitive dye.
            2) Moisture loss during a 72-hour period shall not exceed 9 pounds per
               cubic yard when tested in accordance with ASTM C156.

H. Surface-applied sealing system:
   1. Manufacturers: One of the following or equal:
      a. Euclid Chemical Co., Vandex Super.
      c. Xypex Chemical Corp., Xypex Concentrate.
   2. Where surface-applied sealing system is placed over concrete containing
      permeability reducing admixture for concrete exposed to hydrostatic conditions
      (PRAH), provide products of same manufacturer providing the admixture.

2.05 EQUIPMENT

A. General:
   1. Provide adequate equipment and facilities for accurate measurement and
      control of materials and for readily changing proportions of material into mixers.

B. Batching equipment, or batch plant.
   1. Capable of controlling delivery of all material to mixer within 1 percent by
      weight of individual material.
C. Mixing equipment:
1. Mixers may be of stationary plant, paver, or truck mixer type, as appropriate to the Work.
2. Capable of combining aggregates, water, and cementitious materials, and admixtures within specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation.
   a. Maintain concrete mixing equipment in good working order, and operate at loads, speeds, and timing recommended by manufacturer or as specified.
   b. Proportion cementitious materials and aggregate by weight.
3. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
4. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
5. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
6. Retempering of concrete will not be permitted.
7. Discharge entire batch before recharging.
8. Volume of mixed material per batch: Not exceed manufacturer's rated capacity of mixer.
9. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
10. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
    a. Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.
11. Transit-mixed concrete:
    a. Mix and deliver in accordance with ASTM C94.
    b. Total elapsed time between addition of water at batch plant and discharging completed mix.
    c. Not to exceed 90 minutes.
    d. Elapsed time at project site shall not exceed 30 minutes.
    e. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
    f. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
12. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: For other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.06 CONCRETE MIXES

A. General:
1. Develop and provide mix design for each Concrete Class listed in Table 3 of this Section.
2. Select and proportion mixes and document properties using 1 of the 2 methods that follow. Procedures and requirements for use of each alternative are specified in subsequent paragraphs of this Section.
   a. Field experience method.
   b. Trial batch method.
3. Organize and submit mix designs with data on all constituent materials and products for that mix for Engineer's review.
4. Do not place concrete until the mix design for that Concrete Class has been accepted by Engineer.
5. After acceptance, do not modify accepted mixes or provide new mixes without Engineer's prior review and acceptance of the proposed alternative.
   a. Exception: At all times, adjust batching of water to compensate for free moisture content of the fine aggregate used.
   b. For any change to approved mixes, Engineer may require new trial batching and testing program as specified in this Section before acceptance and use.
   c. For any change to approved mixes, make modifications within limits set forth in this Section.
   d. If there is change in source or quality of any constituent of the concrete class or mix, the revised mix will be considered a new class of concrete and shall require full re-submittal of all data describing mix constituents, design, and testing.
6. Material sampling, mix designs, trial batch preparation and testing, modifications to mix designs, and any re-testing required to satisfy the requirements of this Section or to obtain satisfactory performance shall be at Contractor's expense and shall not be considered cause for delay.

B. Measurements of materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing cementitious materials:
   a. Weigh cementitious materials separately.
   b. Cement in unbroken standard packages (sacks): Need not be weighed.
   c. Weigh bulk cementitious materials and fractional packages.
6. Measure mixing water by volume or by weight.

C. Requirements for mix proportioning:
   1. Develop and provide mixes that:
      a. Can be readily worked into corners and angles of forms and around reinforcement, without excessive vibration, and without permitting materials to segregate or free water to collect on surface.
      b. Prevent unnecessary or haphazard changes in the consistency of the concrete supplied.
   2. Constituent materials:
      a. Provide concrete mixes composed of Portland cement blended aggregates, admixtures and water.
         1) Admixtures required for each concrete class are indicated in Table 3 of this Section. Admixtures not specifically required by that table for a specific Concrete Class are optional and may be included at the discretion of the Contractor based on Contractor’s planned means and methods of construction.
      b. In no case shall returned fresh concrete or its constituents be incorporated into concrete batched for the Work.
   3. Minimum specified compressive strength:
      a. Minimum specified compressive strength is designated at 28 days, unless otherwise indicated in Table 3 of this Section.
      b. For locations where the placed concrete is adequately protected and is not subjected to loads for an extended period during construction, the Contractor may request that the period for achieving the minimum specified compressive strength be extended to 56 days. If accepted by the Engineer, provide mixes that achieve at least 75 percent of their minimum specified compressive strength after 28 days.
   4. Proportions and consistency:
      a. Ratio of water to cementitious materials, and cementitious materials content:
         1) Conform to maximum and minimum cementitious material content requirements specified in Table 3 of this Section.
         2) Cementitious materials content: Consisting of Portland cement as indicated in Table 3 of this Section, plus supplemental cementitious materials if aggregate testing indicates potentially reactive aggregates:
            a) Fly ash content:
               (1) Minimum: 15 percent of the total weight of cementitious materials.
               (2) Maximum: 25 percent of the total weight of cementitious materials.
      b. Aggregate size and content:
         1) Blend aggregates to produce an optimized gradation that combines well-graded coarse, intermediate, and fine aggregates in proportions that maximize the aggregate content of the mix, and that minimize the cement paste content of the mix.
            a) Percentage of individual fractions of the combined aggregate gradation retained on individual sieve sizes: Within the range shown in Attachment C - Combined Aggregate Gradation Chart ("Tarantula Curve").
b) Sum of the percentages of individual fractions retained on the
No. 8, No. 16, and No. 30 sieves: Greater than 20 percent.
c) Sum of the percentages of individual fractions retained on the
No. 30, No. 50, No. 100, and No. 200 sieves: Within the range of
25 percent to 40 percent.

c. Determine bulk density and void content of the combined gradation of
aggregates in accordance with ASTM C29. Results for combined
aggregates shall not be the summation of results of testing of the
individual gradations.
1) Sample the combined aggregate from a flowing aggregate stream or
conveyor in accordance with ASTM D75. Take care to ensure that
the sample is representative of the proportions of the combined
aggregate of the proposed mix.
2) Reduce sample of combined aggregate to test sample size in
accordance with ASTM C702, Method A - mechanical splitter or
Method B - quartering.
3) Perform bulk density test of combined aggregate in accordance with
ASTM C29, Procedure A - rodding.
4) Determine void content of the combined aggregate in accordance
with ASTM C29, Procedure A - rodding. Specific gravity of the
combined aggregate shall be determined in accordance with
ASTM C136.

d. Paste content: Limited to the following:
1) Class A mixes without air entrainment: Maximum 28 percent
measured by volume.
2) Class A mixes with air entrainment: Maximum 28 percent measured
by volume plus the target air content.
3) Paste content shall be limited to 200 percent of the void content of
the combined aggregate gradation determined by ASTM C29.

e. Total water content:
1) Not exceeding the water to cementitious material ratio specified in
Table 3 of this Section.

f. Coarseness/workability (Shilstone Method):
1) Proportion mixes to fall into the "Optimal" zone (Zone II) when plotted
on the Coarseness Factor Chart ("Coarseness Factor" versus
"Workability Factor") included as Attachment B - Coarseness Factor
Chart to this Section. Provide plot for each Class A mix to be used in
the Work.
2) Coarseness factor (CF) for each mix shall be calculated as the
percent of the combined aggregate gradation retained on the 3/8 inch
sieve, divided by the percent of the combined aggregate gradation
retained on the Number 8 sieve, multiplied by 100, or:
\[
CF = \frac{\% \text{ retained on 3/8 in sieve}}{\% \text{ retained on No. 8 sieve}} \times 100
\]
3) Workability factor (WF) for each mix shall be the percent of the
combined aggregate gradation retained on the Number 8 sieve, adjusted for cement content in the mix.
   a) Determine volume of total cementitious material in the mix.
   b) For each 94 pounds of cement content above 564 pounds per
cubic yard, increase workability factor by 2.5 units.
   c) For each 94 pounds of cement below 564 pounds per cubic
yard, decrease workability factor by 2.5 units.
d) Proportion adjustment factor by linear interpolation for each fraction of 94 pounds above or below the 564 pound basis.

   e) Example:
      650 pounds per cubic yard = 564 pounds + 86 pounds.
      Adjustment = (86 lb / 94 lb) x 2.5 = + 2.28.

D. Concrete Classes for use in the Work:
   1. Provide concrete classes listed in Table 3 of this Section.
   2. Provide normal weight concrete, having minimum weight of 140 pounds per cubic foot, unless otherwise noted.
   3. Pumped concrete:
      a. Provide pumped concrete that complies with all requirements of this Section.
      b. Mixes placed by pumping shall be considered a sub-class of each concrete class listed in Table 3 of this Section. Prepare and submit a separate mix design for each mix to be placed by pumping.
   4. Class PM concrete: In addition to the requirements of Table 3 of this Section, conform to the following:
      a. Minimum 28 day flexural strength: 650 psi when tested in accordance with ASTM C293.
      b. Cementitious materials content: 75 percent Portland cement plus 25 percent Class F fly ash (by weight).
      c. Aggregate:
         1) Minimum 55 percent coarse aggregate conforming to ASTM C33 size number 357 or size number 467.
         2) Substitute ASTM C33 size number 57 or size number 67 if mechanical paving equipment is not used.

<table>
<thead>
<tr>
<th>Concrete Class(1)</th>
<th>Minimum Specified Compressive Strength at 28 days, f'c (2) (pounds per square inch)</th>
<th>Ratio of water to cementitious materials (minimum - maximum)</th>
<th>Cementitious Materials Content (pounds per cubic yard of concrete by weight)(3)</th>
<th>Cement Type</th>
<th>Maximum Chloride Content (percent by weight of cement)</th>
<th>Maximum Size of Coarse Aggregate (ASTM C33)</th>
<th>Air Entrainment (percent), (n/a: not applicable)</th>
<th>Admixtures required (4,5,6)</th>
<th>Slump Range (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4,500</td>
<td>0.40 to 0.42</td>
<td>535 to 575</td>
<td>ASTM C150, Type II(MH)</td>
<td>0.30</td>
<td>#57</td>
<td>6+1.5</td>
<td>AEA WRA</td>
<td>2 to 4</td>
</tr>
</tbody>
</table>

Notes:
(1) Sub classes within major concrete classes are designated as follows:
   NA: Without air entrainment.
<table>
<thead>
<tr>
<th>Concrete Class</th>
<th>Minimum Specified Compressive Strength at 28 days, f_c (pounds per square inch)</th>
<th>Ratio of water to cementitious materials (minimum - maximum)</th>
<th>Cementitious Materials Content (pounds per cubic yard of concrete by weight)</th>
<th>Cement Type</th>
<th>Maximum Chloride Content (percent by weight of cement)</th>
<th>Maximum Size of Coarse Aggregate (ASTM C33)</th>
<th>Air Entrainment (percent), (n.a. if not applicable)</th>
<th>Admixtures required&lt;sup&gt;4,5,9&lt;/sup&gt;</th>
<th>Slump Range (inches)</th>
</tr>
</thead>
</table>

(2) At locations where concrete will not be subjected to load from other elements of the structure or from Contractor's placing and/or backfilling operations, maximum time period for achievement of specified compressive strength may be extended to 56 days when accepted by the Engineer.

(3) W/C Ratio = Ratio of water to cementitious materials by weight. Include weight of admixtures in the water content of the mix when the quantity of the admixtures exceeds 10 ounces per 100 pounds of cement.

(4) Cementitious material includes Portland cement plus supplemental cementitious materials. If trial batch testing demonstrates that the required strength cannot be met at 28 or 56 days with the specified combined aggregate gradation and the paste content limits, cementitious material content may be increased with Engineer's approval if Class M concrete is provided and Thermal Control Plan and Temperature Monitoring Program in accordance with Section 03_70_30 - Thermal Control of Concrete is provided for cast-in-place concrete elements. The cement content and/or threshold for the thermal control requirement may be adjusted by the Engineer based on the Equivalent Cement Content (ECC) of the approved Class M concrete mix.

(5) Admixtures are designated as follows:
- AEA: Air entraining admixture.
- HRWR: High-range water-reducing admixture.
- PRAH: Permeability-reducing admixture for concrete exposed to hydrostatic conditions.
- SFR: Synthetic fiber reinforcement.
- SRA: Shrinkage-reducing admixture.
- WRA: Water-reducing admixture.

E. Install Concrete Classes in accordance with the following requirements unless otherwise indicated on the Drawings.

   a. Use Class A concrete for all concrete associated with the Truck Scale Pit as indicated on the drawings.

F. Concrete mix design documented by field experience:

1. Mix design:
   a. Prepare preliminary mix design for each Concrete Class. Submit mix design with product and testing data for materials to be used in the mix for Engineer’s review.

2. Historical records for similar mix:
   a. Determinations of similarity of materials and proportions between historical and proposed mixes shall be by the Engineer, and that shall be final.
   b. Historical record - Materials:
      1) Submit with each mix design the following data for a previously-supplied concrete mix similar to that proposed for this Work.
2) Records demonstrating that the previously supplied mix included similar materials and proportions as those of the proposed mix.
   a) Documentation that the same concrete supplier will provide both mixes.
   b) Documentation that the materials used were from the same suppliers and had essentially the same properties, demonstrated by test data, as those proposed.
   c) Documentation that proportions of materials in the record mix are essentially the same as those proposed and that the specified compressive strength of the record mix is within 1,000 pounds per square inch of that required by this Section.
   d) Concrete supplier's statement describing any changes made to production of the record mix during the time period reported.
   e) Concrete supplier's statement that preparation and quality control procedures for the record mix were essentially the same as those to be employed for this Work.

c. Historical record - Testing:
   1) Submit with each record mix, corresponding test data for slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
   2) Only records satisfying the following requirements will be accepted.
      a) All tests were conducted within a period of 1 year preceding the date of the Submittal.
      b) All tests were conducted over a period including not less than 45 days.
      c) The record of compressive strength testing includes at least 30 tests for slump and 28-day compressive strength.
      d) The record of compressive strength tests is consecutive. In other words, it includes all tests conducted on the subject mix within the 1-year time period described above (not just selected tests during that period).
      e) Submit concrete supplier's sworn statement confirming that all tests for the record mix have been reported.
      f) Tests for drying shrinkage are described in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing".
      g) Provide supplementary testing if requested by Engineer.

d. For mixes determined to be similar and to have an acceptable test history, acceptance criteria shall be as follows:
   1) Acceptance criteria:
      a) Slump: All tests within limits specified for record mix.
      b) Compressive strength: Average compression strength for tests, as determined by ACI CODE-350 not less than minimum required average strength.
      c) Drying shrinkage: Within limits stated in subsequent paragraphs of this Section for "concrete mix design documented by trial batch preparation and testing".
G. Concrete mix design documented by trial batch preparation and testing:
   1. Mix design and trial batches:
      a. Prepare preliminary mix design for each Concrete Class. Submit mix
design with product and testing data for each combination of materials
and proportions to be used for Engineer's review.
      1) Determine water content of the mix based on curves showing the
relation between water-cementitious materials ratio and the 7- and
28-day compressive strength of the concrete.
      2) Determine each curve using 4 or more points, each representing the
average compressive strength value of at least 3 specimens tested at
each age.
      b. After materials and proposed mix designs have been accepted by
Engineer, have trial batches for each concrete mix design prepared by
Contractor's testing laboratory.
      1) Prepare trial batches using the cementitious materials, aggregates,
and admixtures proposed to be used for the Work.
      2) Provide batches of sufficient quantity to determine slump, workability,
consistency, setting time and finishing characteristics, and to provide
sufficient specimens for testing.
      c. For each trial batch, make and test specimens to determine and report
slump, compressive strength (with relationships for rate of strength gain
between testing ages), and drying shrinkage.
      1) If trial batches do not produce concrete conforming to the specified
requirements for slump, strength, workability, consistency, drying
shrinkage, restrained shrinkage, and finishing, change mix
proportions and, if necessary, sources of materials.
      2) Make additional trial batches and perform additional tests until a
batch that conforms to requirements of this Section is produced.
   2. Testing - Slump:
      a. Determine slump in accordance with ASTM C143.
      b. Acceptance criterion: Slump within range specified.
   3. Testing - Compressive strength:
      a. Prepare 4 inch diameter by 8 inch long cylinders in accordance with
ASTM C31 for tests specified in this Section.
      b. Determine average compressive strength:
         1) Test at least 12 cylinders from each trial batch for compressive
strength in accordance with ASTM C39.
         2) Test 4 cylinders at 7 days, another 4 at 28 days. Deliver 1 final
cylinder to Engineer at 56 days.
         3) Calculate average compression strength for 7 day tests, for 28 day
tests, and for 56 day tests.
         4) Calculate ratios for:
            a) Average 7 day strength to average 28 day strength.
            b) Average 28 day strength to average 56 day strength.
      c. Determine the required average compressive strength for each mix, f'cr,
as described in the following paragraphs:
         1) Calculate required average compressive strength (f'cr) based on the
minimum specified 28-day compressive strength, f'c, plus a standard
deviation determined from the test history available for that mix.
2) Determine $f'_{cr}$ as specified in ACI CODE-350, except as modified in the following paragraphs:
   a) Where 15 or more 28-day compressive strength tests are available, calculate standard deviation as described in the preceding paragraphs for "concrete mix design documented by field experience". Add this standard deviation to the specified minimum compressive strength to determine the required average compressive strength ($f'_{cr}$) for the mix.
   b) Where fewer than 15 compressive strength tests at 28 days are available, determine minimum required compressive strength, ($f'_{cr}$) from Table 4 of this Section.

<table>
<thead>
<tr>
<th>Table 4: Required Average Compressive Strength, Fewer than 15 Tests Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Specified Compressive Strength, $f_c$</td>
</tr>
<tr>
<td>(pounds per square inch)</td>
</tr>
<tr>
<td>Less than 3,000</td>
</tr>
<tr>
<td>3,000 to 5,000</td>
</tr>
<tr>
<td>Over 5,000</td>
</tr>
</tbody>
</table>

d. Acceptance criterion: Average compressive strength of the 4 cylinders tested at 28 days, or of the 4 cylinders tested at 56 days when permitted by the Engineer, shall equal or exceed the required average compression strength, $f'_{cr}$ for that concrete mix design.

4. Testing - Chloride content:
   a. Submit test results showing that the concrete mix contains water-soluble chloride ion content contributed from the constituents including water, aggregates, cementitious materials, and admixtures is less than the limit specified in Table 3 of this Section. Test shall be performed in accordance with ASTM C1218 at age between 28 and 42 days.

5. Testing - Drying shrinkage - Prism specimens:
   a. Class A (including A, A-NA, A-SP, and A-NA-SP) and Class PM: From trial batch for each mix, prepare 10 drying shrinkage specimens in accordance with ASTM C157 Divide specimens into 2 groups of 5 specimens each: 1 group including shrinkage-reducing admixture, and 1 group without shrinkage-reducing admixture.
   b. Prepare, cure, and test both groups in accordance with ASTM C157, except as modified in the following paragraphs.
      1) Remove drying shrinkage specimens from molds at age of 23 hours, plus or minus 1 hour, after trial batching.
         a) Immediately place them in lime-saturated water maintained at 73 degrees Fahrenheit, plus or minus 3 degrees, for at least 30 minutes.
         b) Remove specimens from the water and wipe with a damp cloth.
         c) Measure to nearest 0.0001 inch to determine original length.
         d) Record measurements and re-submerge specimens in lime-saturated water at 73 degrees Fahrenheit, plus or minus 3 degrees, for moist curing.
      2) Maintain submerged curing conditions at 73 degrees Fahrenheit, plus or minus 3 degrees, for 7 days. 7 days after batching, remove specimens from water and repeat measuring procedures.
3) Immediately store specimens in a humidity controlled room maintained at 73 degrees Fahrenheit, plus or minus 3 degrees, and at 50 percent relative humidity plus or minus 4 percent for remainder of the test.
4) At periods of 14, 21, 28, and 56 days after batching, remove specimens from curing room and repeat measurements.

   c. Drying shrinkage test report:
      1) Report measurements of all specimens at 1, 7, 14, 21, 28, and 56 days after batching.
      2) Using measured length at 7 days as base length for drying shrinkage, calculate the following for each measuring period:
         a) Drying shrinkage of each specimen. Determine as difference between the 7-day base length and measured length for each period.
         b) Average of these differences. If drying shrinkage of any specimen departs from the average of the measurements for each period by more than 0.0004 inch, disregard results obtained from that specimen.
         c) Percentage of drying shrinkage from batching to date of measurement.

d. Drying shrinkage acceptance criteria:
   1) Average shrinkage of trial batch concrete specimen group at 28 days after batching, when measured and cured as indicated, shall not exceed 0.035 percent.

e. Mixes accepted by Engineer:
   1) Retain drying shrinkage test specimens. Bag in re-sealable plastic bags and submit to Engineer.
   2) Indicate trial batch identifier, specimen number, and date of final measurements on each specimen bag.

2.07 SOURCE QUALITY CONTROL

   A. Sample and test materials in accordance with the following requirements:
      1. Sampling, testing, and reporting frequency:
         a. In preparation for mix design submittals and trial batch tests.
         b. Whenever there is a change in source of the material, or a significant change in the characteristics or quality of materials from the same source.
         c. For each 10,000 cubic yards of concrete mix produced.
         d. At intervals not exceeding 90 calendar days, unless otherwise specified in the following paragraphs.

      2. Supplemental cementitious materials.
         a. Sample and test fly ash in accordance with ASTM C311.

      3. Aggregate:
         a. Sample combined aggregate in accordance with ASTM D75 and D3665, and test for gradation in accordance with ASTM C136.
         b. At least once every 30 days, and when requested by the Engineer.
         c. Submit test results.

      4. Cementitious materials:
         a. Sample and test cementitious materials and provide mill certificates demonstrating compliance with ASTM C150 and additional requirements of this Section.
            1) Determine alkali content by method set forth in ASTM C114.
b. At least once every 90 days, and when requested by the Engineer.
c. Submit test results.

B. Batch materials in accordance with the following requirements:
1. Concrete batch weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
2. Aggregates:
   a. Obtain aggregate from a source capable of providing uniform quality, moisture content, and grading during any single day’s operation.
   b. Furnish satisfactory means at batching plant for checking moisture content of fine aggregate for each batch.
3. Admixtures:
   a. Batch solutions using mechanical batcher capable of accurate measurement.
   b. Air entraining admixture: Add to batch portion of the mixing water, unless otherwise recommended by the admixture manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare and submit mix designs for each Concrete Class indicated in Table 3 of this Section.

B. Submit proposed sequence of concrete placements. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested by the Contractor and accepted by the Engineer.
   1. Use construction methods and sequence work to allow concrete placement to reach adequate strength and to be constructed with required support to prevent overstress of the concrete structure during construction.

C. Make provisions for monitoring weather conditions:
   1. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
   2. Monitor the weather forecast beginning at least 48 hours prior to any concrete placement and make provisions for cold weather concreting or hot weather concreting if those conditions exist or are forecast to exist during the period of placement, finishing, and curing.
      a. Record temperature, relative humidity, and wind speeds for each placement beginning at least 24 hours before scheduled delivery of concrete.

D. Place no concrete without Engineer’s prior acceptance of conditions.

E. Notify the Engineer in writing that preparations are complete and ready for placement of concrete. Such notification shall indicate readiness - not just intention - to place concrete for the designated portion of the Work.
   1. Submit notification to Engineer on forms provided by or acceptable to the Engineer and bearing the signature of Contractor’s superintendent.
      a. Sample form is included at the end of this Section, see Attachment B - Coarseness Factor Chart.
2. Submittal of notification will be Contractor's certification that preparations are complete and in accordance with the Contract Drawings and Specifications.
3. Provide notification for Engineer to make final observations at the locations of concrete placements not less than 24 hours before commencing placement of concrete.

3.02 CONCRETE JOINTS

A. Locations of joints for the Truck Scale Pit shall be as determined by the Delegated Design Professional.
   1. In order to preserve strength and watertightness of structures, make no other joints, except as authorized by the Engineer.
   2. Submit Contractor's proposed locations for Engineer's review and acceptance. Provide construction joints in slabs and walls at intervals not greater than 35 feet.

B. Time between placements of adjacent concrete separated by joints.
   1. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
      a. Slabs.
      b. Walls.
   2. Provide not less than 7 days (168 hours) between placement of the lower and upper pours for the following:
      a. Walls over slabs.
      b. Slabs over walls.
      c. Slabs keyed into the sides of walls.

C. Edges of joints:
   1. Provide joints have edges detailed as indicated on the Drawings.
   2. Protect wall and slab surfaces at edges from concrete splatter. Thoroughly clean adjacent surfaces after completion of each placement.

D. Keyways in joints:
   1. Provide keyways in joints unless specifically noted otherwise on the Drawings.
   2. Treat lumber keyway material with form release coating, applied in accordance with manufacturer's instructions.

E. Joint construction:
   1. Preparation of forms:
      a. Provide cleanout holes at base of each wall and column for inspection and cleaning.
      b. Wash forms and adjacent joint surfaces of sawdust, chips, and other debris after forms are built, and immediately before concrete or grout placement.
      c. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use a vacuum cleaner for their removal, and then flush cleaned surfaces with water.
   2. Before placing concrete against previously placed concrete, thoroughly clean the prior placement of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of pressure washing.
3. Provide and install waterstops, expansion joint material, and other similar materials as specified in section 01_35_73 Delegated Design Procedures.
   a. Take special care to ensure that waterstops are secured in proper position.
   b. Take special care to ensure that concrete is well consolidated around and against waterstops during placement.

4. Horizontal joints:
   a. As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03_60_00 - Grouting.
      1) Thickness: Not less than 1/2 inch or more than 1 inch.
   b. For wall placements above planned cold joints, placement of cement grout will not be required for locations where the wall mix includes high-range water-reducing admixture ("superplasticizers"), and the Contractor can demonstrate dense concrete joints without voids or honeycomb after the forms are removed.

3.03 MEASURING AND BATCHING MATERIALS

A. Measurements of materials:
   1. Proportion and measure cementitious materials and aggregates by weight.
      a. Weigh cementitious materials separately.
      b. If bulk cementitious materials are used, weigh them on separate visible scale that will accurately register scale load at any stage of weighing operation from zero to full capacity.
      c. Cement in unbroken standard packages (sacks) need not be weighed.
   2. Mixing water: Measure by volume or by weight.
   3. Other mix constituents: Measure by weight, except as otherwise specified or accepted by the Engineer.

B. Weighing and measuring devices:
   a. Use equipment designed and constructed specifically for that purpose.
   b. Furnish devices capable of weighing successive quantities of individual material measured to within 1 percent of desired weight of that material.
   c. Bearing valid seal of the department of weights and measures for the authority having jurisdiction over the Work.

5. Measurements and measuring devices:
   a. Subject to review by the Engineer.

B. Batching:
   1. Admixtures shall be added at the concrete batch plant.
   2. Addition of admixtures in the field is permitted only with prior acceptance by the Engineer, and only when the following conditions are satisfied:
      a. The dosage and mixing is personally overseen by concrete supplier's trained technologist.
      b. Adequate mixing is provided after addition.
      c. The maximum time to placement of concrete remains 90 minutes after water added to mix - not 90 minutes after any field additions/adjustments.
      d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.
3.04 MIXING AND TRANSPORTING

A. Machine mixing:
1. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer and ready for complete mixing with all mixing water.
2. Procedure of mixing cementitious materials with sand, or with sand and coarse aggregate, for delivery to project site for final mixing and addition of mixing water is not permitted.
3. Remimixing of concrete that has started to take its initial set ("retempering") is not permitted.
4. Discharge entire batch before recharging.
5. Volume of mixed material per batch: Not exceeding manufacturer's rated capacity of mixer.

B. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C94, except as modified in this Section.
2. Total elapsed time between addition of water at batch plant and discharging completed mix:
   a. Not to exceed 90 minutes or 300 revolutions of the mixing drum.
   b. Under conditions contributing to rapid setting, total elapsed time permitted may be reduced by the Engineer.
3. Temperature - minimum and maximum allowable during mixing and transporting:
   a. Minimum: 50 degrees Fahrenheit.
   b. Maximum: 95 degrees Fahrenheit.
4. Continuously revolve drum after it is started until it has completely discharged its batch:
   a. Do not add water until drum has started revolving.
   b. Engineer reserves the right to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. Contractor will not be entitled to additional compensation because of such increase or decrease.

C. Concrete delivery:
1. Furnish to the Engineer a delivery ticket for each batch of ready mixed concrete within 24 hours after delivery. Include the following information on each ticket:
   a. Time of day concrete was batched, and time of day that discharge from the truck is complete.
   b. Printed record of the individual weight of each of the following constituents in the batch: Fine aggregate, coarse aggregate, cement, pozzolan, and water.
   c. Concrete Class as defined in Table 3 of this Section.
   d. Type, brand, and quantity of each admixture in the batch.
   e. Total volume of water allowed in the mix, volume of mixing water added at the batch plant, volume of mixing water withheld from the mix during
batching, and total volume of any water added to the mix after leaving the batch plant.

1) In no case shall volume of mixing water withheld result in a water/cementitious materials ratio less than the minimum values specified in Table 3 of this Section.

f. Number of revolutions of transit truck at arrival on site, and total number of revolutions when discharge is complete.

g. Volume of concrete delivered in the batch.

h. Numerical sequence of the batch delivered for that placement.

2. Additional water may only be added to the mix when the following conditions are fully satisfied:

a. Batch ticket showing total volume of water already added and maximum volume of water that may be added is available for Engineer’s observation before any additional water is added.

b. Total volume of water in the mix after the addition will be less than the maximum allowable volume of water indicated on the ticket.

c. The full concrete load is still within the truck’s mixing drum, and truck has not begun to discharge the load. Under no conditions shall water be added in the field to a partial truckload of concrete.

d. Volume of water added, and time of addition are clearly marked for record on the batch ticket delivered to the Engineer.

3. Addition of admixtures in the field is permitted only with prior approval by the Engineer, and when the following conditions are satisfied:

a. Dosage and mixing is personally overseen by concrete supplier’s trained technologist and admixtures supplier’s representative.

b. Adequate mixing time is provided after addition of admixtures.

c. The maximum time to placement of concrete remains 90 minutes after water is added to the mix - not 90 minutes after any field additions/adjustments.

d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.

D. Conveying concrete:

1. Convey concrete from mixer to location of final deposit by methods that prevent separation or loss of materials.

2. Use equipment for chutes, pumps, and conveying of concrete of such size and design as to ensure practically continuous flow of concrete, from delivery to the point of placement, without separation of materials.

3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.

4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day’s placement.

3.05 PLACING AND CONSOLIDATING

A. Preparation:

1. Obtain Engineer’s acceptance of completed preparations before placing concrete.

a. Notify Engineer in writing that all preparations are complete and ready for placement of concrete. Such indication shall indicate readiness, not just intention, to place concrete for the designated portion of the Work.
b. Submit completed Attachment D - Contractor’s Concrete Placement Checklist Form.

2. Confirm completeness of the following before notification of readiness is given to Engineer:
   a. Place forms, reinforcement, screeds, anchors, ties, and inserts in final position.
   b. Reinforcement is secure and properly fastened in its correct position.
   c. Loose form ties at construction joints have been retightened.
   d. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
   e. Forms have been cleaned of debris and form release agents are applied as specified.

3. Preparation for placement of footings and slabs on grade:
   a. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
   b. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
   c. If subgrade surface becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
   d. Do not place concrete if subgrade is muddy or soft.

4. Keep sufficient protective coverings on hand at all times for protection of concrete during and after placement.
   a. Protect concrete placed before rain to prevent water from coming in contact with such concrete.
   b. Protect concrete placed before winds to prevent excessive drying or embedding of debris in the finished surfaces.

B. Concrete Placement:
   1. Do not place concrete:
      a. With slump outside the limits specified in Table 3 of this Section.
      b. In which initial set has occurred, or that has been retempered.
      c. During rainstorms or high velocity winds.
   2. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
      a. Do not deposit concrete in large quantities in one place, and then work material along forms with vibrators or by other methods.
   3. Do not drop concrete freely into place from height greater than 5 feet. Use tremies for placing concrete where drop is over 5 feet.
   4. Place concrete on slopes starting from bottom of slope and working upward.
   5. Place concrete in horizontal lifts not exceeding 24 inches in depth and bring up evenly in all parts of forms.
   6. After concrete placement begins, continue in a continuous operation without significant interruption until the end of the placement. Plan and implement precautions to prevent any delay, between layers or adjacent volumes, from exceeding 20 minutes.
   7. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout over surface before placing additional concrete. Provide grout layer thickness of not less than 1/2 inch or more than 1 inch.
8. Placement of concrete for slabs, beams, or walkways:
   a. If cast monolithically over walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
   b. Allow set time of not less than 1 hour for shrinkage.
      1) During waiting time, keep top surface of concrete moist, but not wet.
      2) Do not permit water to pond or stand on the surface.
      3) Do not coat surface with evaporation retarders or curing agents.
   c. Start placement above wall or column with layer of cement grout as described in the preceding paragraph.

C. Consolidating concrete:
   1. Consolidate concrete with aid of acceptable mechanical vibrators.
   2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the Work.
   3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
   4. Vibrators:
      a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
      b. In addition to vibrators in actual use while concrete is being placed, have on hand a minimum of 1 spare vibrator in operable condition.
      c. Do not place concrete until it has been confirmed that all vibrating equipment, including spares, are in operable condition.
   5. Place concrete solidly against forms and concrete surfaces, leaving no voids or honeycomb.
   6. Make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.
   7. Do not over-vibrate so as to produce segregation.

3.06 FINISHING CONCRETE

A. Provide concrete finishes in accordance with Section 03_35_29 - Tooled Concrete Finishing unless otherwise indicated on the Drawings.

B. Liquid evaporation retardant:
   1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, coat the surface of the concrete with a liquid evaporation retardant immediately after screeding.
   2. Conditions that result in rapid evaporation of moisture are defined as any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.1 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI PRC-305 and included as Attachment A - Menzel Formula and Nomograph to this Section.
   3. Apply evaporation retardant again after each finishing operation as necessary to prevent drying shrinkage cracks.
   4. Do not work evaporation retardant into the surface of the concrete.
   5. Do no use evaporation retardant as finishing aid (to rehydrate surface a creamy state for finishing).
C. Concrete sealer:
   1. Floors and slabs to receive concrete sealer: See Room Finish Schedule on the
      Drawings, and Section 03_35_29 - Tooled Concrete Finishing.

3.07 CURING

A. Cure concrete by methods specified in this Section.

B. Keep concrete continuously moist and at an average daily temperature of at least
   50 degrees Fahrenheit for a minimum of 7 days after placement.
   1. Provide at least 350 degree days of curing (350 degrees times 7 days of
      24 hours each).
   2. If hourly temperatures at any surface of a concrete placement drop below
      50 degrees Fahrenheit during the curing period, count the period below
      50 degrees Fahrenheit as zero degrees, and extend the curing time to
      compensate.

C. Schedule of curing methods:
   1. Cure the following concrete surfaces using water curing, or plastic membrane
      curing.
      a. Floor surfaces of water containment structures.
      b. Surfaces where additional concrete will be placed over or against the
         surface, including concrete joints.
      c. Surfaces where grout or other toppings will be placed over the surface.
      d. Slabs scheduled to receive concrete sealer, or other bonded or adhered
         architectural finishes.
      e. Formed surfaces scheduled to receive coatings, paint, adhered masonry,
         cementitious materials, or other similar finishes, and where formwork is
         removed within 7 days after concrete placement.
      f. Horizontal concrete surfaces at tops of walls.
   2. Cure the following concrete surfaces by water curing, plastic membrane
      curing, or sprayed curing membrane. Selection of methods shall be at the
      Contractor's option.
      a. Surfaces not listed in the preceding paragraph.

D. Water curing:
   1. Keep surfaces of concrete constantly and visibly wet, day and night, for period
      of not less than 7 days.
      a. Each day forms remain in place will be counted as 1 day of water curing.
      b. Do not loosen form ties during period when concrete is cured by leaving
         forms in place. No further curing credit will be allowed for forms remaining
         in place after contact has been broken between concrete surface and
         forms.
   2. Begin water curing as soon as concrete attains initial set.
   3. Maintain a wet surface by ponding, continuous sprinkling, covering with
      saturated burlap, or otherwise saturating the surface by means acceptable to
      Engineer.
      a. Flood top of walls with water at least 3 times per day and keep surfaces
         moist at all times during the 7-day curing period.
      b. Provide plastic sheet material over surfaces if required to maintain a wet
         surface during arid or windy conditions. See plastic membrane curing
         requirements for additional details.
4. Use water having a temperature within 20 degrees Fahrenheit of the temperature of concrete, and not lower than the minimum temperature allowed for the concrete surface during curing.

E. Plastic membrane curing:
1. Install plastic membrane as soon as concrete is finished and can support limited pedestrian traffic without damage.
2. Cover entire surface of finished concrete with membrane.
3. Anchor membrane to prevent uplift from wind or air trapped below the sheet.
4. Fully seal joints and edges to provide full seal around perimeter.
5. Keep concrete under plastic membrane moist, regularly monitoring surfaces and adding supplemental moisture if necessary. Add water as specified for water curing.

F. Sprayed membrane curing compound:
1. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   a. If more than 1 hour elapses after removal of forms, do not use membrane curing compound. Instead, provide water curing for not less than 7 days.
   b. Do not remove sprayed membrane curing compound from concrete in less than 7 days after initial application.
   c. When application of curing compound at concrete joints is accepted by Engineer, take care to apply curing compound to all surfaces along full profile of joints.
2. Apply curing compound by mechanical, power operated sprayer with mechanical agitator that will uniformly mix all pigment and compound.
   a. Apply curing compound in at least 2 coats.
   b. Apply each coat in direction turned 90 degrees from application direction of the preceding coat.
   c. Apply curing compound in sufficient quantity so that concrete has uniform appearance and its natural color is effectively and completely concealed immediately after spraying.
   d. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
3. Thickness and coverage of curing compound:
   a. Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
   b. Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and is more than is customary in the trade. Apply amounts specified in this Section, regardless of manufacturer’s recommendations or customary practice.
4. If Contractor desires to use a curing compound other than specified product, coat sample areas of concrete wall with proposed curing compound, and also coat similar adjacent area with the specified compound in the manner specified, for comparison:
   a. If proposed sample is not equal or better, in opinion of the Engineer, the proposed substitution will not be allowed.
5. Removal of curing compound:
   a. After curing period is complete, remove curing compound placed on surfaces that will receive additional concrete, including all concrete joint surfaces, by heavy sandblasting or by other means acceptable to
Engineer. Complete removal and cleanup prior to placing any new concrete against the surface.

b. Where additional finishes will be applied over concrete surfaces, unless otherwise recommended by the manufacturer of the finish to be applied, remove curing compound by sandblasting. Provide blasting as necessary to fully remove curing compound.

6. Prior to final acceptance of the Work, remove, by sandblasting or by other method acceptable to the Engineer, any curing compound on surfaces exposed to process water or exposed to view, so that only natural color of finished concrete is visible and uniform over the entire surface.

3.08 PROTECTION

A. General:
   1. Keep forms in place, as specified in Section 03_11_07 - Concrete Formwork, to provide curing and to protect concrete surfaces and edges from damage.
   2. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified.

B. Loading of concrete members:
   1. Placement of loads on or against green concrete is not permitted.
   2. Do not place soil against walls, or fill over the top of concrete until conditions designated in the following paragraphs are satisfied:
      a. Walls have been cast to their full height in the structure and have achieved their minimum specified 28-day compressive strength.
      b. Connecting slabs and beams that brace the walls are in place, are complete, and (in the case of concrete) have achieved their minimum specified 28-day compressive strength.

3.09 COLD WEATHER CONCRETING

A. Implement cold weather concreting procedures during periods of cold weather as defined in this Section.
   1. Comply with the recommendations of ACI PRC-306 and this Section.

B. Prepare a cold weather concreting plan. Maintain at least 1 copy of the plan on site. Provide plan for review if requested by the Engineer.
   1. Include procedures for batching, delivery, placement, curing, protection, and for monitoring and recording the temperature of the concrete and the surrounding environment.
   2. Describe procedure to be implemented in the event of abrupt changes in weather conditions or of equipment failure.
   3. Review cold weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete over frozen subgrade materials. Provide insulating material and supplementary heat if required to maintain a thawed surface.
   2. Do not place concrete around metallic elements whose temperature is less than 40 degrees Fahrenheit. If heating is required, use processes that do not alter the metallurgical properties of the elements.
3. Remove snow, ice, and frost from reinforcement, embedments and forms. Schedule such removal immediately before concrete placement so that surfaces do not refreeze.

D. Batching, delivery, placement and finishing:
1. Accelerating admixtures will not be permitted.
2. Based on temperature of the environment and the surfaces where concrete will be placed, select and maintain mix temperature as recommended in ACI PRC-306.
   a. Make provisions for temperature loss during delivery and placing.
   b. Place concrete at or slightly above the minimum recommended batch temperatures. Do not exceed these minimum values by more than 20 degrees Fahrenheit.
3. Heating: If temperature of water or aggregates is below 35 degrees Fahrenheit, heat the materials.
   a. Mixing water: Do not heat above 140 degrees Fahrenheit.
   b. Aggregates:
      1) Heat uniformly to eliminate ice, snow, and frozen lumps of material.
      2) Avoid overheating.
      3) Do not exceed average temperature of 140 degrees Fahrenheit or spot temperature of 200 degrees Fahrenheit.

E. Protection and curing:
1. Protect concrete to provide continuous warm moist curing immediately after placement and during protection period.
2. Minimum protection period: 7 days until concrete reaches specified minimum compressive strength.
3. For placements of Class M concrete, do not use steam or other concrete heating methods that will increase concrete temperature outside the limits of Section 03_70_30 - Thermal Control of Concrete.
4. During and immediately after the protection period, maintain temperature in accordance with Table 5 of this Section. Provide record of temperature during placement and curing as specified in the following paragraphs.
   a. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete.

<table>
<thead>
<tr>
<th>Table 5: Concrete Temperatures - Normal Weight Concrete</th>
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<tr>
<td>Section Thickness (inches)</td>
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<tr>
<td>During Protection Period:</td>
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<tr>
<td>As maintained (minimum)</td>
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<tr>
<td>After Protection Period:</td>
</tr>
<tr>
<td>Gradual drop during first 24 hours (maximum)</td>
</tr>
</tbody>
</table>

5. Provide plastic sheeting, polystyrene foam sheets, insulating blankets, and supplemental heating if required to maintain moisture and the specified temperatures during protection.
   a. Protect insulating blankets from moisture in the concrete and from rain or snow using impermeable sheeting.
   b. Supplemental heating units:
      1) Vent units to outside atmosphere. Do not exhaust heater flue gasses into the enclosed and protected area.
2) Make provisions to heat the flow freely within protected area, and to maintain a uniform temperature throughout the space.

3) Locate units to avoid local drying or uneven heating of concrete surfaces.

c. Pay particular attention to maintaining required temperature and moisture at edges and corners.

6. At the end of the protection period, allow concrete to cool gradually to the ambient temperature.
   a. Maximum temperature drop over the first 24-hour period shall be as specified above.
   b. Where temperature of concrete exceeds ambient by 20 degrees Fahrenheit or more, loosen forms and leave in place for at least 24 hours before removal.
   c. If water curing has been used, maintain concrete temperature as specified in the following paragraphs for at least 24 hours after water curing is terminated. Allow water-cured concrete to air dry for at least 3 days before exposure to freezing temperatures.

F. Temperature records:
   1. For each area of concrete placed or cured during cold weather, record the temperature of concrete and the ambient environment.
      a. Maintain temperature records on site and make records available for review by the Engineer upon request.
      b. Deliver a final copy of each record to Engineer for project files not more than 14 calendar days after the date concrete was placed.
   2. Concrete delivered for placement.
      a. Measure and record temperature at the point of discharge in accordance with ASTM C1064.
      b. Note temperature on the batch ticket.
   3. Concrete during the protection period:
      a. Furnish and locate self-recording thermometers (maximum/minimum) around each placement. Number and location of thermometers shall be sufficient to represent temperatures around the entire concrete placement.
      b. Position thermometers to record the temperature at each edge or corner and at the middle of the placement area.
   4. Include in the temperature record of each placement the following information, recorded legibly on a single sheet.
   5. In the event that evaluations of the efficacy of concrete protection and curing are required, the lowest temperature recorded in any placement during each 24-hour period will be assumed to be the temperature at which the entire placement was maintained. Protection periods with any temperature records will be assumed to have provided no protection or curing, and the protection period will be extended by 2 days for each day without protection.

3.10 HOT WEATHER CONCRETING

A. Implement hot weather concrete procedures during periods of hot weather as defined in this Section.
   1. Comply with the recommendations of ACI PRC-305 and this Section.
B. If placements during hot weather are expected, and when requested by the Engineer, prepare a hot weather concreting plan.
   1. Maintain at least 1 copy on site.
   2. Provide plan for review if requested by the Engineer.
      a. Include procedures for batching, delivery, placement, curing, protection, and monitoring and recording the temperature of the concrete and the surrounding environment.
      b. Describe procedures to be implemented in the event of abrupt changes in weather conditions, or in the event of equipment failure.
      c. Review hot weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete against forms, reinforcement, or embedments with a surface temperature greater than 120 degrees Fahrenheit.
      a. If necessary, to maintain maximum concrete temperature during placing, cool forms and reinforcement to temperature below 90 degrees Fahrenheit using water or shades.
      b. Do not allow water to puddle in forms or placement areas.
   2. Moisten forms or subgrade to maintain a saturated surface without standing water or soft spots.
   3. Provide windbreaks, shades, fog spray, sprinkling, wet cover, or other means required to protect concrete from premature loss of moisture and rapid temperature gain.

D. Batching and delivery:
   1. Retarding admixtures will not be permitted.
   2. Temperature of concrete delivered for placement shall not exceed 90 degrees Fahrenheit.
      a. Maintain uniform temperature in the mix below this level during batching, delivery, placing, and consolidation.
      b. Temperature of mix, even if below the maximum allowable temperature specified, shall be maintained at a level to avoid loss of slump, flash setting, or cold joints in placements.
   3. If necessary:
      a. Mix water may be chilled or replaced with ice to maintain mix temperature. Where mix water is replaced with ice, provide replacement at a 1-to-1 ratio by weight.
      b. Shade transit mixed concrete trucks, or cool mixing outside of container with water to control temperature of concrete.

E. Placing and finishing:
   1. Place and finish concrete promptly. Place so that vertical lift lines will not be visible in exposed concrete surfaces.
   2. Provide plastic sheeting, fog nozzles, shades or other means to reduce concrete temperature and protect from moisture loss.

F. Protection and curing:
   1. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete temperatures over full area and edges of concrete.
2. Flatwork: Protect and cure using water curing methods as specified in this Section.
   a. Water curing:
      1) Keep concrete continuously wet and make provisions for runoff.
      2) For sprinkling or soaker hoses, maintain temperature of water as close as possible to the temperature of the concrete to minimize effects of thermal shock.
   b. Formed surfaces: Protect and cure using forms left in place or membrane curing methods as specified in this Section.
      a. Cover forms and keep continuously moist for at least 24 hours after placement.
      b. Loosen forms as soon as this can be accomplished without damaging the concrete.
      c. Maintain continuously moist surfaces by fogging or spraying with water, or by application of curing compound as specified.

3.11 FIELD QUALITY CONTROL BY CONTRACTOR

A. Provide quality control over the Work of this Section as required by Section 01_45_00 - Quality Control.

B. Field tests:
   1. During progress of construction, provide testing to determine whether the concrete, as being produced, complies with requirements specified.
   2. Sampling and testing shall be performed by Contractor's testing laboratory. See Section 01_45_00 - Quality Control - Special Tests and Inspections for requirements.
      a. Cooperate in testing by allowing free access to the Work for testing laboratory to sample and test materials.
      b. Provide full access for Engineer to observe concrete sampling and testing at any time.
      c. Contractor is responsible for providing care of and curing conditions for test specimens in accordance with ASTM C31 until specimens are collected by testing laboratory.
      d. Provide 4 firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold 10 specimens. Include cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication through shipment to Owner's testing laboratory.
   3. Testing shall include:
      a. Sampling of concrete in accordance with ASTM C172.
      b. Temperature of concrete at delivery in accordance with the requirements of ASTM C1064 and as specified in this Section.
      c. Slump of concrete using slump cone in accordance with requirements of ASTM C143. Test slump at the following intervals:
         1) At the beginning of each placement.
         2) As often as necessary to keep slump within the specified range, but not less than every 6th truck.
         3) When requested to do so by the Engineer.
         4) Observe concrete during slump test for signs of segregation.
            a) Observe concrete to see if mortar or moisture flows from slumped concrete.
            b) Reject concrete if mortar or moisture flows out of mix.
d. Unit weight of concrete in accordance with ASTM C138.

e. Air entrainment in accordance with ASTM C173. Test air content at the following intervals:
   1) At beginning of each placement.
   2) As often as necessary to keep entrained air within specified range, but not less than every 6th truck.
   3) When requested to do so by the Engineer.
   4) Test air entrainment in concrete in accordance with ASTM C173. If air entraining admixtures used for the Work require alternate testing procedures, advise the independent testing laboratory well in advance of the dates of testing, and confirm that appropriate equipment and personnel are provided for the test.
   5) Make air test at point of delivery (discharge from mixer). For pumped concrete, make air tests at point of delivery and at point where expelled after pumping for placement.

f. Compressive strength in accordance with ASTM C39. Required number of cylinders is as follows:
   1) Not less than 6 cylinder specimens, 4 inches in diameter by 8 inches long, will be tested for each 150 cubic yards of each class of concrete, with minimum of 6 specimens for each class of concrete placed; not less than 6 specimens for each half day's placement; and not less than 2 sets of 6 specimens for each structure.
   2) 1 cylinder will be broken at 7 days, 1 at 14 days, and 3 at 28 days. The 6th cylinder may be used to evaluate strength after 28 days if requested by the Engineer.
   3) Retain and store "6th cylinders" (tested and untested) at testing laboratory until 56 days. Break "6th cylinder" when directed by the Engineer.

g. Provide full access for Engineer to observe concrete sampling and testing at any time.

C. Test completed liquid containment structures listed in Section 01_75_19 - Water Leakage Test for Concrete Structures for watertightness.

3.12 FIELD QUALITY CONTROL BY OWNER

A. Provide on-site inspection and field quality assurance for the Work of this Section as specified in Section 01_45_00 - Quality Control.

B. Special tests and inspections: See Section 01_45_00 - Quality Control.

C. Field inspections:
   1. Required inspections:
      a. Observe construction for conformance to the Contract Documents and the accepted submittals.
   2. Records of inspections:
      a. Provide record of each inspection.
      b. Submit copies to Contractor upon request.
D. Field tests:
   1. Engineer may request, at any time, additional testing to confirm that materials
      being delivered and placed conform to the requirements of the Contract
      Documents.
         a. If such additional testing shows that the material do not conform to the
            specified requirements, Contractor shall pay the cost of these tests.
         b. If such additional testing shows that the materials do conform to the
            specified requirements, Owner will pay the cost of these tests.

3.13 NON-CONFORMING WORK

A. Remove and replace or repair non-conforming and defective work.
   1. Provide repairs having strength equal to or greater than specified concrete for
      areas involved.
   2. Provide replacement or repair of non-conforming work by means acceptable to
      the Engineer and at no additional cost to Owner.
   3. Project schedule will not be extended based on work to address
      non-conforming concrete.

B. Concrete not conforming to the specified requirements for properties of plastic
   concrete: Remove from the site and replace with conforming materials at no
   additional cost to Owner.
   1. Temperature: Do not use concrete having a temperature above or below the
      limits specified in this Section.
   2. Slump: Do not place concrete that does not conform to requirements for
      slump.
   3. Air entrainment: Do not use concrete that does not conform to requirements
      for percentage of entrained air.

C. Concrete not conforming to the specified requirements for compressive strength:
   1. Concrete is expected to reach a compressive strength equal to or greater than
      the minimum specified compressive strength f'c in Table 3 of this Section.
   2. Strength of concrete will be considered acceptable if following conditions are
      satisfied.
      a. Averages of all sets of 3 consecutive strength test results is greater than
         or equal to the specified compressive strength f'c.
      b. No individual strength test (average of 3 cylinders) falls below the strength
         specified in Table 6 of this Section.
      c. Where relationships between 7-day and 28-day compressive strength, or
         between 28-day and 56-day compressive strength, have been provided as
         part of the mix design submittals:
            1) 7-day strength may be considered as an indication of 28-day strength
               provided effects of temperature and humidity between 7 days and
               28 days are taken into account.
            2) 28-day strength may be considered as indication of 56-day strength
               provided effects of temperature and humidity between 28 days and
               56 days are taken into account.
Table 6: Strength Compliance Requirements

<table>
<thead>
<tr>
<th>Minimum Specified Compressive Strength, f′c (pounds per square inch)</th>
<th>Lower Bound of an Individual Compressive Strength Test (pounds per square inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5,000</td>
<td>f′c - 500</td>
</tr>
<tr>
<td>Over 5,000</td>
<td>f′c - (0.10 x f′c)</td>
</tr>
</tbody>
</table>

3. Non-compliant strength tests.
   a. Mark non-compliant strength test reports to highlight the non-complying results, and immediately forward copies to all parties on the test report distribution list.
   b. Initial treatment may consist of additional curing of affected portion(s) followed by not less than 3 cores at each affected area, taken in accordance with ASTM C42 and ACI CODE-318. Obtain Engineer's acceptance of proposed coring locations before proceeding with that work.
   c. Submit report of compressive strength testing for Engineer's review.
   d. If requested by the Engineer, provide additional cores, and obtain petrographic testing in accordance with ASTM C856. Submit results for Engineer's review.
   e. If additional curing does not bring the average strength of 3 cores taken in affected area to at least specified compressive strength f′c, designate such concrete in affected area will be considered defective.
   f. Engineer may require the Contractor to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all at the Contractor's expense.

D. Concrete sections or surfaces with honeycombing and voids:
   1. Provide repairs having surface appearance and finish consistent with that of the surrounding work and acceptable to the Engineer.
   2. Do not patch, repair, or cover defective Work without prior inspection by the Engineer.
   3. Preparation of concrete for repair:
      a. Make no repair until Engineer has accepted methods for preparing surfaces and for making and curing repairs.
      b. Chip out and key-in imperfections in the Work to make them ready for repair.
      c. Coat bonding surfaces and edges of repair area with one of the following bonding agents as accepted by the Engineer.
         1) Epoxy bonding agent as specified in Section 03_63_01 - Epoxies; or
         2) Epoxy resin/Portland cement bonding agent as specified in Section 03_63_02 - Epoxy Resin/Portland Cement Bonding Agent.
   4. Methods of repair:
      a. Dry pack mortar method:
         1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
         2) Smooth Holes: Clean and roughen by heavy sandblasting before repair.
         3) Install dry-pack mortar as specified in Section 03_60_00 - Grouting.
b. Cement mortar method:
   1) Use for holes too wide to dry pack and too shallow for concrete replacement; and for comparatively shallow depressions, large or small, that extend no deeper than nearest surface reinforcement.
   2) Install cement mortar as specified in Section 03_60_00 - Grouting.

c. Concrete replacement:
   1) Use when holes extend entirely through the concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
   2) Form, place, consolidate, and cure concrete of same mix as the surrounding work.

E. Leaking construction joints and cracks in concrete walls and slabs:
   1. Repair cracks that develop in walls or slabs, and repair cracks that show any signs of leakage until all leakage is stopped.
   2. Pressure inject visible cracks in the following areas, other than hairline cracks and crazing, with repair products and methods acceptable to the Engineer.
      a. Floors and walls of water bearing structures.
      b. Walls and overhead slabs of passageways and occupied spaces where the opposite face of the member is exposed to weather or may be washed down and where the opposite face does not receive a separate waterproofing membrane.
      c. Other items not specified to receive separate waterproofing membrane including slabs over water channels, wet wells, reservoirs, and other similar surfaces.
   3. Continue pressure injection of cracks as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

F. Leaking expansion joints in concrete walls or slabs that include waterstops:
   1. Repair any signs of leakage until all leakage is stopped.
   2. Pressure inject visible leaks with hydrophilic polyurethane foam resin as specified by Engineer.
   3. Continue pressure injection along joints lines as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

G. Walls and slabs at overhead channels that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy.
   1. Seal on water or weather side by coating using surface-applied sealing system as specified in this Section.
   2. Apply as recommended by manufacturer published instructions. Where concrete continues to sweat or leak, apply additional coats of surface-applied sealing system until the sweating or leaks stop.
   3. Continue application of surface-applied sealing system until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion, or date of final repair, whichever occurs later in time.

END OF SECTION
ATTACHMENT A - MENZEL FORMULA AND NOMOGRAPH
MENZEL FORMULA AND NOMOGRAPH

Source: ACI PRC-350

Fig. 2.1.5—Effect of concrete and air temperatures, relative humidity, and wind speed on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use this chart, follow the four steps outlined above. If the rate of evaporation approaches 0.2 lb/ft²·h (1 kg/m²·h), precautions against plastic-shrinkage cracking are necessary (Levy 1957). Wind speed is the average horizontal air or wind speed in mph (knots) and should be measured at a level approximately 20 ft, (5.1 m) higher than the evaporating surface. Air temperature and relative humidity should be measured at a level approximately 4 to 6 ft (1.2 to 1.8 m) higher than the evaporating surface on its windward side shielded from the sun’s rays (PCA Journal 1957).
Fig. 8.9.2.2—Coarseness factor chart for evaluating potential performance of mixture.
ATTACHMENT C - COMBINED AGGREGATE GRADATION CHART
ATTACHMENT D - CONCRETE PLACEMENT CHECKLIST
CONCRETE PLACEMENT CHECKLIST

Project: ___________________________ Class of Concrete: ___________________________
Project No.: ________________________ Test Cylinders Taken? Yes: _____ No: _____

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<thead>
<tr>
<th>Preparation Slab</th>
<th>Contractor</th>
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<tbody>
<tr>
<td>Compaction Subgrade</td>
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<tr>
<td>Filter Fabric/Drain Rock-ABC/Separator Fabric</td>
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<tr>
<td>Drain Rock, Pea Gravel &amp; Void Form</td>
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<td>Starter Wall Forms</td>
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<tr>
<td>Reinforcing Steel</td>
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<td>Screeds</td>
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<td>D. Electrical</td>
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<td>F. Mechanical</td>
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<td>G. HVAC</td>
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<td>C. Hoppers</td>
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<td>D. Vibrators</td>
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<td>E. Elephant trunks</td>
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<td>Clean up and Washed Out</td>
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<th>Record of Curing Conditions During Placement</th>
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Location of Placement

The Contractor certifies the above-proposed concrete placement is prepared as indicated and is in accord with the Contract Drawings and Specifications. The Contractor requests permission to begin placement of concrete on the date of ___________ at ___________. The estimated number of yards is ___________. The estimated duration of the placement is ________________.

By: _______________________________
Contractor

Released for placement by: ____________________________
Engineer

Cast-in-Place Concrete
03_30_00-Attachment D-1

12062A10
April 2023
SECTION 03_35_29

TOOLED CONCRETE FINISHING

PART 1  GENERAL

1.01  SUMMARY

A. Section includes: Tooled concrete finishes for structural concrete associated with Truck Scale Pit, Truck Scale Sump Pit, Project Sign and miscellaneous concrete.

1.02  QUALITY ASSURANCE

A. Mock-ups:
   1. Test panels for concrete finishes:
      a. Prepare test panels for F4 and F5 finishes and tie-hole repairs for review by Engineer.
      b. Accepted test panels serve as standard of quality and workmanship for project.
   2. Prepare test panel showing horizontal and vertical joints proposed for project for review by the Engineer. Refer to finishes specified in this Section.
   3. Test panels indicating methods for making concrete repairs: Prepare test panels for proposed repairs at beginning of project for review by Engineer:
      a. Accepted test panels serve as standard for repairs during the project.

1.03  DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2  PRODUCTS

2.01  MIXES

A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

B. Mortar mix for F5 finish: Consist of 1 part cement to 1-1/2 parts of sand which passes Number 16 screen.

2.02  CONCRETE SEALER

A. Manufacturers: One of the following or equal:
   1. Euclid Chemical Company: Diamond Hard.
   2. L&M Construction Chemicals: SealHard.
PART 3 EXECUTION

3.01 CONCRETE FINISHES

A. Cement for finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Finish vertical concrete surfaces with one of the following finishes as indicated in the Finish Schedule:
   1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing compound.
   2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing compound.
   3. F3 finish: Repair defective work, remove fins, offsets, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing compound.
   4. F4 finish: Receive same finish as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar.
      a. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
      b. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
      c. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
      d. Do not let any material remain on surfaces, except that within pits and depressions.
      e. Wipe surfaces clean and moist cure.
   5. F5 finish: Receive same finish as specified for F3 finish, and, in addition, receive special stoned finish, in accordance with following requirements:
      a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
      b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of portland cement per gallon.
      c. Rub surfaces until form marks and projections have been removed.
      d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
      e. Moist cure brushed surfaces and allow to harden for 3 days:
         1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
         2) Continue curing for remainder of specified time.
    f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not.
       1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and handstoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
       2) Continue stoning until surface is hard.
3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 60 grit carborundum stone.

4) Afterstoning, continue curing until 7 day curing period is completed.

C. Finish horizontal concrete surfaces with one of the following finishes as indicated in the Finish Schedule after proper and adequate vibration and tamping:

1. S1 finish: Screeded to grade and leave without special finish.
2. S2 finish: Smooth steel trowel finish.
3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hairbroom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish is subject to review and acceptance by the Engineer.
5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
6. S6 finish: Roughened finish: After concrete has been screeded to grade, apply a roughened finish by use of a jitterbug roller or similar device.

D. Finish concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISH SCHEDULE

A. Finish concrete surfaces as follows:

1. F4 finish for following vertical surfaces:
   a. Concrete surfaces specified or indicated to be painted.
   b. Concrete surfaces, interior or exterior, exposed to view.
   c. Concrete walls for Truck Scale Sump Pit.

2. F5 finish for vertical surfaces above grade concrete associated with Plant Sign foundation as indicated on Drawing S-102. F3 for vertical services below grade.

3. Surfaces in open channels, basins, and similar structures:
   a. F3 finish for vertical surfaces which are normally below water surface.
   b. F4 finish for vertical surfaces located above normal water surface and exposed to view.
   c. Remove fins and fill tie holes from concrete surfaces located in closed boxes or channels where there is normally no access or passageway.

4. S1 finish for following surfaces:
   a. Projecting footings which are to be covered with dirt.
   b. Slab surfaces which are to be covered with concrete fill.

5. S2 finish for following surfaces:
   a. Tops of corbels.
   b. Tops of walls and beams not covered above in this Section.
   c. Tops of slabs not covered above in this Section.
d. All other surfaces not specified to be finished otherwise.

6. S3 finish for following surfaces:
   a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.

7. S4 finish for following surfaces:
   a. Exterior walkways.
   b. Tops of exterior walls or beams which are to serve as walkways.
   c. Tops of exterior walls or beams which are to support gratings.
   d. Top surface of slabs for basins, channels, digesters, and similar structures.
   e. Truck Scale Pit interior base surface

8. S6 finish for following surfaces:
   a. Basin bottoms, or other similar slab surfaces, over which layer of basin bottom grout will be applied.
   b. Top of sign foundation.

END OF SECTION
SECTION 03_60_00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   5. Non-shrink epoxy grout.

1.02 REFERENCES

A. ASTM International (ASTM):

B. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
   1. Mix design.

B. Cement mortar:
   1. Mix design.
C. Non-shrink epoxy grout:
   1. Manufacturer's literature.

D. Non-shrink grout:
   1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
   1. Manufacturers: One of the following or equal:
      c. L&M Construction Chemicals, Inc., EPOGROUT.
   2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
   3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
   4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
   5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
   6. Compressive creep: Not exceed 0.0037 inches per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
   7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

B. Non-shrink grout:
   1. Manufacturers: One of the following or equal:
      b. Master Builder Solutions, MasterFlow 928.
      c. L&M Construction Chemicals, Inc., CRYSTEX.
   2. In accordance with ASTM C1107.
   3. Preportioned and prepackaged cement-based mixture.
   4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
   5. Require only addition of potable water.
   7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
   a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
   a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
   b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

A. Cement grout:
   1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
   2. Use same materials for cement grout that are used for concrete.
   3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
   4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
   1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
   2. Use same materials for cement mortar that are used for concrete.
   3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
   4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
   1. Proportions by weight: 1 part Portland cement to 2 parts concrete sand.
      a. Portland cement: As specified in Section 03_30_00 - Cast-in-Place Concrete.
      b. Concrete sand: As specified in Section 03_30_00 - Cast-in-Place Concrete.

D. Grout:
   1. Mix in proportions by weight: 1 part Portland cement to 4 parts concrete sand.
      a. Portland cement: As specified in Section 03_30_00 - Cast-in-Place Concrete.
      b. Concrete sand: As specified in Section 03_30_00 - Cast-in-Place Concrete.

E. Non-shrink epoxy grout:
   1. Mix in accordance with manufacturer's installation instructions.

F. Non-shrink grout:
   1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.
PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
   1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
   2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
      a. Remove loose or broken concrete.
   3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
   1. Cement grout:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Dry-patch mortar:
      a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
   4. Non-shrink epoxy grout:
      a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
   5. Non-shrink grout:
      a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
      b. Do not retemper by adding more water after grout stiffens.

B. Placement:
   1. Cement grout:
      a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
      b. Do not use cement grout that has not been placed within 30 minutes after mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Non-shrink epoxy grout:
      a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
      b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add
aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause
air entrapment in mix.

4. Non-shrink grout:
   a. Add non-shrink cement grout to premeasured amount of water that does
      not exceed the manufacturer's maximum recommended water content.
   b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
   1. Cement based grouts and mortars:
      a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker
         hose, sun shading, ponding, and in extreme conditions, combination of
         methods.
      b. Maintain above 40 degrees Fahrenheit until it has attained compressive
         strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit
         for minimum of 24 hours to avoid damage from subsequent freezing.
   2. Epoxy based grouts:
      a. Cure grouts in accordance with manufacturers' recommendations.
         1) Do not water cure epoxy grouts.
      b. Do not allow any surface in contact with epoxy grout to fall below
         50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As required by
   delegated design professional for truck scale support beams connections to
   concrete. See Section 10.35.73 Delegated Design Procedures.

E. Grouting other baseplates:
   1. General:
      a. Use non-shrink grout as specified in this Section.
      b. Baseplate grouting shall take place from 1 side of baseplate to other in
         continuous flow of grout to avoid trapping air in grout.
      c. Maintain hydrostatic head pressure by keeping level of grout in headbox
         above bottom of baseplate. Fill headbox to maximum level and work grout
         down.
      d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate
         grout, and remove trapped air.
   2. Forms and headboxes:
      a. Build forms using material with adequate strength to withstand placement
         of grouts.
      b. Use forms that are rigid and liquidtight. Caulk cracks and joints with
         elastomeric sealant.
      c. Line forms with polyethylene for easy grout release. Coating forms with
         2 coats of heavy-duty paste wax is also acceptable.
      d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located
         on 1 side of baseplate.
      e. After grout sets, remove forms and trim back grout at 45 degree angle
         from bottom edges of baseplate.
3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
   1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.

B. Non-shrink grout:
   1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION
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PART 1    GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in anchors and fasteners:
      a. Anchor bolts.
   2. Post-installed steel anchors and fasteners:
      a. Concrete anchors.
   3. Appurtenances for anchoring and fastening:
   4. Anchoring of Truck Scale to Truck Pit shall conform to the requirements of the
drawings and as determined by the delegated design professional as specified
in Section 10_35-73- Delegated Design Procedures.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete &
      Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for
      Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped,
      Zinc-Coated, Welded and Seamless.
      and Steel Products.
      Hardware.
      Steel Plate, Sheet, and Strip for Pressure Vessels and for General
      Applications.
   6. A380 - Standard Practice for Cleaning, Descaling, and Passivation of
      Stainless Steel Parts, Equipment, and Systems.
      and Steel.
      Iron and Steel.
  12. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and
      Studs.

   1. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

A. Built-In Anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.

B. Cast-In Anchor: Headed bolt or assembly installed in position before placing plastic concrete around.

C. Overhead Installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.

D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel’s protective passive film.

E. Post-Installed Anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.

F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
   1. Corrosive locations: Describes interior and exterior locations as follows:
      a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
      b. Exterior and interior locations at the Truck Scale pit, Sign, and Truck scale sump pump pit.

1.04 SUBMITTALS

A. General:
   1. Submit as specified in Section 01_33_00 - Submittal Procedures.
   2. Submit information listed for each type of anchor or fastener to be used.

B. Action submittals:
   1. Product data:
      a. Cast-in anchors:
         1) Manufacturer’s data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
      b. Post-installed anchors:
         1) For each anchor type, manufacturer’s data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
2. Samples:
   a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.

3. Certificates:
   a. Cast-in anchors:
      1) Mill certificates for steel anchors that will be supplied to the site.
   b. Post-installed anchors:
      1) Manufacturer’s statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.

4. Test reports:
   a. Post-installed anchors: For each anchor type used for the Work:
      1) Current ICC-ES Report (ESR demonstrating:
         a) Acceptance of that anchor for use under the building code specified in Section 01_41_00 - Regulatory Requirements.

5. Manufacturer’s instructions:
   a. Requirements for storage and handling.
   b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
   c. Requirements for inspection or observation during installation.

6. Qualification statements:
   a. Post-installed anchors: Installer qualifications:
      1) Submit list of personnel performing installations and include date of manufacturer’s training for each.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Post installed anchors shall be in accordance with building code specified in Section 10_35_73 - Delegated Design Procedures.
   2. Installers: Post-installed mechanical anchors:
      a. Conduct a training session with the manufacturer’s authorized technical representative for the project on-site:
         1) Training shall cover the complete installation process for each type of anchor to be used and shall include, but not be limited to, hole drilling procedures and techniques, hole preparation and cleaning, bolt installation, and bolt proof loading and torquing.
         2) Use only trained and qualified personnel for anchor installation.
      b. Installations shall be performed by trained installers having at least 3 years of experience performing similar installations with similar types of anchors.

B. Special inspection:
   1. Delegated Design Professional shall be responsible to Provide special inspection of post-installed anchors for the Truck Scale and Truck Scale Cabinet supports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver post-installed anchors in manufacturer’s standard packaging with labels visible and intact. Include manufacturer’s installation instructions.
B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

C. Protect anchors from weather and moisture until installation.

1.07 PROJECT CONDITIONS

A. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings provided by the delegated design professional or as specified in this Section. In the event of conflicts, contact Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings provided by the delegated design professional or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Description:
      a. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings provided by the delegated design professional or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
      b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer.
         1) Rods or bars with angle bend for embedment in concrete (i.e., “L” or “J” shaped anchor bolts) are not permitted in the Work.
   2. Materials:
      a. Ship anchor bolts with properly fitting nuts attached
      b. Type 316 stainless steel:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
         2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
4) Washers: Type 316 stainless steel.

B. Steel plates or shapes for fabrications including assemblies with welded studs or deformed bar anchors:
   1. Stainless steel: Type 316L or Type 304L:
   2. Galvanized steel:
      a. Hot dip galvanized in accordance with ASTM A123.
      b. Steel: ASTM A36

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete:
As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All
Thread Rods in Concrete.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors used for the Work shall hold a current ICC Evaluation
      Service Report demonstrating acceptance for use under the building code
      specified in Section 01_41_00 - Regulatory Requirements.
      a. Conditions of use: The acceptance report shall indicate acceptance of the
         product for use under the following conditions:
            1) In regions of concrete where cracking has occurred or may occur.
            2) To resist short-term loads due to wind forces.
            3) To resist short-term loading due to seismic forces for the Seismic
               Design Category of the structure where the product will be used.
   2. Substitutions: When requesting product substitutions, submit calculations,
      indicating the diameter, effective embedment depth and spacing of the
      proposed anchors, and demonstrating that the substituted product will provide
      load resistance that is equal to or greater than that provided by the anchors
      listed in this Section.
      a. Calculations shall be prepared by and shall bear the signature and seal of
         a
      b. Decisions regarding the acceptability of proposed substitutions shall be at
         the discretion of the Engineer.

B. Concrete anchors:
   1. Description. Post-installed anchor assembly consisting of a threaded stud and
      a surrounding wedge expansion sleeve that is forced outward by torquing the
      center stud to transfer loads from the stud to the concrete through bearing,
      friction, or both. (Sometimes referred to as “expansion anchors” or “wedge
      anchors.”)
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation
         of lead alloy or similar materials to develop holding power.
   2. Concrete anchors for anchorage to concrete:
      a. Acceptance criteria:
         1) Concrete anchors shall have a current ICC-ES Report demonstrating
            that the anchors have been tested and qualified for performance in
both cracked and un-cracked concrete, and for short-term loading
due to wind and seismic forces for Seismic Design Categories A
through F in accordance with ACI 355.2 and with ICC-ES AC193
(including all mandatory tests and optional tests for seismic tension
and shear in cracked concrete).
2) Concrete anchor performance in the current ICC-ES Report shall be
“Category 1” as defined in ACI 355.2.
b. Manufacturers: One of the following or equal:
   1) Hilti, Kwik Bolt TZ Expansion Anchor.
   2) DeWALT/Powers, PowerStud.
   3) Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.
c. Materials. Integantly threaded stud, wedge, washer, and nut:
   1) Stainless steel: Type 316.
       a) Type 304 stainless steel acceptable for use at wet and moist
          locations when accepted in writing by the Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this
Section. If unsatisfactory conditions exist, do not begin this Work until such
conditions have been corrected.

3.02 INSTALLATION: GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or
specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
   1. Post-installed anchors may not be used as an alternative to cast-in/built-in
      anchors at locations where the latter are indicated on the Drawings.
   2. Cast-in/built-in anchors may be used as an alternative to post-installed
      mechanical anchors at locations where the latter are indicated on the
      Drawings.

C. Protect products from damage during installation. Take special care to protect
   threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
   1. Unless otherwise indicated on the Drawings, install anchors perpendicular to
      the surfaces from which they project.
   2. Install anchors so that at least 2 threads, but not more than 1/2 inch of
      threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum,
      stainless steel, etc.), use stainless steel anchors and separate or isolate
dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread
      coating to prevent galling of threads.
3.03 INSTALLATION: CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors.
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
      b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
      c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
      d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
   2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
   3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
   1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.

3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

B. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in masonry: As specified in Section 04_05_18 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

3.05 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

A. General:
   1. Install anchors in accordance with the manufacturer's instructions, ACI 355.2, the anchor’s ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
   2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
   3. After anchors have been positioned and inserted into concrete or masonry, do not:
      a. Remove and reuse/reinstall anchors.
      b. Loosen or remove bolts or studs.
B. Holes drilled into concrete and masonry:
   1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
   2. Accurately locate holes:
      a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
      b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
   3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
      a. If embeddings are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.
   4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
   5. Drill using anchor manufacturer’s recommended equipment and procedures:
      a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
         1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
         2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.
   6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
   7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
      a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
      b. Repeat cleaning process as required by the manufacturer’s installation instructions.
      c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in full compliance with the manufacturer’s installation instructions.
   1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

<table>
<thead>
<tr>
<th>Nominal Diameter</th>
<th>Minimum Effective Embedment Length</th>
<th>Minimum Member Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Concrete</td>
<td>In Grouted Masonry</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>2 1/2 inch</td>
<td>2 5/8 inch</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>3 1/2 inch</td>
<td>3 1/2 inch</td>
</tr>
<tr>
<td>5/8 inch</td>
<td>4 1/2 inch</td>
<td>4 1/2 inch</td>
</tr>
</tbody>
</table>
Concrete Anchors

<table>
<thead>
<tr>
<th>Nominal Diameter</th>
<th>Minimum Effective Embedment Length</th>
<th>Minimum Member Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Concrete</td>
<td>In Grouted Masonry</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>5 inch</td>
<td>5 1/4 inch</td>
</tr>
</tbody>
</table>

3.06 FIELD QUALITY CONTROL

A. Contractor shall provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.
   1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
   1. Review anchor manufacturer’s installation instructions and requirements of the Evaluation Service Report (hereafter referred to as “installation documents”) for each anchor type and material.
   2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
   3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner will provide on-site observation and field quality assurance for the Work of this Section.
   1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer’s installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to Engineer upon request.
   3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector’s statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
   a. Anchor:
      1) Type and dimensions.
      2) Material: Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
      3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
      4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.

3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
   a. Base material concrete:
      1) Solid and dense concrete material within required distances surrounding anchor.
      2) Material encapsulating embedment is dense and well-consolidated.

D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors.
      a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.
   3. Requirements for periodic special inspection:
      a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
         1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new "initial inspection."
      b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor's rated strength.
      c. Anchor:
         1) Manufacturer, type, and dimensions (diameter and length).
         2) Material (Type 304 stainless steel, or Type 316 stainless steel).
      d. Hole:
         1) Positioning: Spacing and edge distances.
         2) Drill bit type and diameter.
         3) Diameter, and depth.
         4) Hole cleaned in accordance with manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
         5) Anchor's minimum effective embedment.
         6) Anchor tightening/installation torque.
4. Requirements for continuous special inspection:
   a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
   1. Owner may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
      a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
      b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.
   2. Field testing: Post-installed anchors:
      a. Proof load testing:
         1) In addition to performing special inspections, the Owner may select up to 10 percent of each type and size of post-installed mechanical anchor for proof-load testing for pullout or shear. Tests shall be non-destructive whenever possible.
         2) Perform tension testing in accordance with ASTM E488. Apply proof loads using a calibrated hydraulic ram.
      b. Torque load testing:
         1) Using a calibrated torque wrench, apply manufacturer’s recommended installation torque.
      c. Acceptance criteria:
         1) Minimum anchor embedment, proof load for pullout and shear, and torque shall be as specified in this Section.
         2) Anchors that fail to resist their designated proof load or installation torque requirements shall be regarded as non-performing.
         3) If more than 10 percent of the tested anchors fail to achieve their specified torque or proof load, all anchors of the same diameter and type as the failed anchors shall be tested.
         4) Remediate non-performing anchors as specified in “non-conforming work.”

3.08 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

END OF SECTION
SECTION 05_50_00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Handrails and guardrails.
   2. Ladders.
   3. Manhole frames and covers as necessary to adjust pavement grades.
   4. Metal gratings.
   5. Miscellaneous metals for fabrication of Truck Scale Cabinet Supports.
   6. Associated accessories to the above items.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45: Designations from Start to Finish.
      a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):

C. ASTM International (ASTM):
   10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

D. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

E. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product Data:
   1. Handrails and guardrails.
   2. Manhole frames and covers.
   3. Metal grating.

B. Shop drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.
      b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
      c. Include erection drawings, elevations, and details where applicable.
      d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Metal grating.
   3. Miscellaneous metals. Provide shop drawings detailing the size, location of all welds for the delegated design of the truck scale cabinet supports provided by the delegated design professional in accordance with Section 01.32-73-Delegated design procedures.

C. Samples:
   1. Guardrails with specified finishes.

D. Quality control submittals:
   1. Design data.
2. Test reports:
   a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current State and OSHA strength requirements.
   b. Gratings:
      1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
      2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

<table>
<thead>
<tr>
<th>Item</th>
<th>ASTM Standard No.</th>
<th>Class, Grade Type or Alloy No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cast Iron</td>
<td>A48</td>
<td>Class 40B</td>
</tr>
<tr>
<td>Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galvanized sheet iron or steel</td>
<td>A653</td>
<td>Coating G90</td>
</tr>
<tr>
<td>Coil (plate)</td>
<td>A635</td>
<td></td>
</tr>
<tr>
<td>Structural plate, bars, rolled shapes, and miscellaneous items (except W shapes).</td>
<td>A36</td>
<td>--</td>
</tr>
<tr>
<td>Rolled W shapes</td>
<td>A992</td>
<td>Grade 50</td>
</tr>
<tr>
<td>Standard bolts, nuts, and washers</td>
<td>A307</td>
<td></td>
</tr>
<tr>
<td>High strength bolts, nuts, and hardened flat washers</td>
<td>F3125, Grade A325</td>
<td>--</td>
</tr>
<tr>
<td>Eyebolts</td>
<td>A489</td>
<td>Type 1</td>
</tr>
<tr>
<td>Tubing, cold-formed</td>
<td>A500</td>
<td></td>
</tr>
<tr>
<td>Tubing, hot-formed</td>
<td>A501</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>ASTM Standard No.</td>
<td>Class, Grade Type or Alloy No.</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Steel pipe</td>
<td>A53</td>
<td>Grade B</td>
</tr>
<tr>
<td><strong>Stainless Steel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plate, sheet, and strip</td>
<td>A240</td>
<td>Type 304* or 316**</td>
</tr>
<tr>
<td>Bars and shapes</td>
<td>A276</td>
<td>Type 304* or 316**</td>
</tr>
<tr>
<td>Bolts (Type 304)</td>
<td>F593</td>
<td>Group 1 Condition CW</td>
</tr>
<tr>
<td>Bolts (Type 316)</td>
<td>F593</td>
<td>Group 2 Condition CW</td>
</tr>
<tr>
<td><strong>Aluminum</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flashing sheet aluminum</td>
<td>B209</td>
<td>Alloy 5005-H14, 0.032 inches minimum thickness</td>
</tr>
<tr>
<td>Structural sheet aluminum-</td>
<td>B209</td>
<td>Alloy 6061-T6</td>
</tr>
<tr>
<td>Structural aluminum</td>
<td>B209, B308</td>
<td>Alloy 6061-T6</td>
</tr>
<tr>
<td>Extruded aluminum</td>
<td>B221</td>
<td>Alloy 6063-T42</td>
</tr>
</tbody>
</table>

* Use Type 304L if material will be welded.
** Use Type 316L if material will be welded.

1. Stainless steels are designated by type or series defined by ASTM.
2. Where stainless steel is welded, use low-carbon stainless steel.

**2.02 MANUFACTURED UNITS**

1.

B. Handrails and guardrails:
1. General:
   a. Design and fabricate assemblies to conform to current local, State, and OSHA standards and requirements.
   b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
      1) Indicate on the shop drawings locations of such equipment.
      2) Highlight locations where railings cannot be made continuous, and obtain Engineer’s directions on how to proceed before fabricating or installing railings.
2. Aluminum handrails and guardrails (nonwelded pipe):
   a. Rails, posts, and fitting-assembly spacers:
      1) In accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
   b. Kick plates: 6061 or 6105 aluminum alloy.
   c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
   d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
      1) Fabrications: In accordance with ASTM B209 or ASTM B221 extruded bars:
         a) Bases: 6061 or 6063 extruded aluminum alloy.
      2) Plug screws or blind rivets: Type 305 stainless steel.
         a) Other parts: Type 300 series stainless steel.
   e. Finish of aluminum components:
      1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
      2) Pretreat aluminum for cleaning and removing markings before anodizing.
   f. Fabrication and assembly:
      1) Fabricate posts in single, unspliced pipe length.
      2) Perform without welding.
      3) Do not epoxy bond the parts.
      4) Maximum clear opening between assembled railing components as indicated on the Drawings.
   g. Manufacturers: One of the following or equal:
      1) Moultrie Manufacturing Co., Wesrail.
      2) Golden Railings, Riveted System.
      3) Craneveyor Corp. Enerco Metals, C-V Rail.

3. Fastenings and fasteners: As recommended or furnished by guardrail manufacturer for use with this system.

C. Manhole frames and covers:
   1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
   2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
   3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
   4. Frame:
      a. Bottom flange type.
      b. Approximately 4-1/2 inches frame height.
      c. Dimensions as requirement by the City of Tulsa Standards.
   5. Cover:
      a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as "ELECTRICAL," "SEWER," "TELEPHONE," or "WATER."
      b. Solid type without ventilation holes.
      c. Conforming to the City of Tulsa Standards.
D. Metal gratings:
   1. General:
      a. Fabricate grating to cover areas indicated on the Drawings.
      b. Unless otherwise indicated on the Drawings, grating over an opening shall
         cover entire opening.
      c. Make cutouts in grating where required for equipment access or
         protrusion, including valve operators or stems, and gate frames.
      d. Band ends of grating and edges of cutouts in grating:
         1) End banding: 1/4 inch less than height of grating, with top of grating
            and top edge of banding flush.
         2) Cutout banding: Full-height of grating.
         3) Use banding of same material as grating.
         4) Panel layout: Enable installation and subsequent removal of grating
            around protrusions or piping.
         5) Openings 6 inches and larger: Lay out grating panels with edges of
            2 adjacent panels located on centerline of opening.
         6) Openings smaller than 6 inches: Locate opening at edge of single
            panel.
         7) Where an area requires more than 1 grating section to cover area,
            clamp adjacent grating sections together at 1/4-points with fasteners
            acceptable to Engineer.
         8) Fabricate steel grating sections in units weighing not more than
            50 pounds each.
         9) Fabricate aluminum grating sections in units of weighing not more
            than 50 pounds each.
      10) Gaps between adjacent grating sections shall not be more than the
            clear spacing between bearing bars.
      e. When requested by Engineer, test 1 section of each size grating for each
         span length involved on the job under full load:
            1) Furnish a suitable dial gauge for measuring deflections.
      f. Grating shall be aluminum, unless otherwise specified or indicated on the
         Drawings.

   2. Aluminum grating:
      a. Material for gratings, shelf angles, and rebates: 6061-T6 or
         6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum
         alloy.
      b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
      c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
      d. Bar size and spacing: As determined by manufacturer to enable grating to
         support design load.
      e. Design live load: A minimum of 100 pounds per square foot uniform live
         load on entire grating area, but not less than the live load indicated on the
         Drawings for the area where grating is located.
      f. Maximum fiber stress for design load: 12,000 pounds per square inch.
      g. Maximum deflection due to design load: 1/240 of grating clear span.
      h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
      i. Minimum grating height: 1-1/2 inches.
      j. Manufacturers: The following or equal:
         1) Harsco Industrial IKG, Swaged Aluminum I-Bar with striated finish.
3. Heavy-duty steel grating:
   a. Heavy-duty type, fabricated from structural steel and designed in accordance with AASHTO Standard Specifications for Highway Bridges, using H-20 loading.
   b. Hot-dip galvanized after fabrication in accordance with ASTM A123.
   c. Manufacturers: One of the following or equal:
      1) Reliance Steel Products Co., Heavy-Duty Steel Grating.
      2) Seidelhuber Metal Products, Inc., equivalent product.

E. Miscellaneous aluminum:
1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
2. Do not weld or flame cut.

F. Miscellaneous stainless steel:
1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings provided by delegated design profession or specified elsewhere.
   a. Fabricate and install in accordance with the best practices of the trade.
2. Cleaning and passivation:
   a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
   b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
   c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
      1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
   d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
      1) Passivation by citric acid treatment is not allowed.
         a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
      2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
      3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A380.
   e. After cleaning, inspect using methods specified for "gross inspection" in ASTM A380.
   f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

G. Isolating sleeves and washers:
1. As indicated on the Drawings and as specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
PART 3  EXECUTION

3.01  EXAMINATION

A.  Verification of conditions:
   1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
   2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02  INSTALLATION

A.  General:
   1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals.
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05.05.24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09.96.01 - High Performance Coatings.
      c. Aluminum in contact with concrete or masonry.

B.  Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.
      b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint-gap.
      c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
      d. Space attachment brackets as indicated in the manufacturer's instructions.
   2. Aluminum pipe handrails and guardrails:
      a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.
      b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.
      c. Discontinue handrails and guardrails at lighting fixtures.
      d. Provide 1/8-inch diameter weep hole at base of each post.
      e. Space posts as indicated on the Drawings.
      f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete, or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
      g. Space rails as indicated on the Drawings.
h. Make adequate provision for expansion and contraction of kick plates and rails.
   1) Make provisions for removable sections where indicated on the Drawings.

i. Make lower rails a single, unspliced length between posts, or continuous.

j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.

k. Draw up fasteners tight with hand wrench or screw driver.

l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.

m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.

n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.

o. Replace damaged or disfigured handrails and guardrails with new.

p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.
   1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.

q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.

C. Manhole frames and covers:
   1. Installation: As recommended by Manufacturer.

D. Metal gratings:
   1. General:
      a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.
      b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
      c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.
      d. Install angle stops at ends of grating.
      e. Installed grating shall not slide out of rebate or off support.
      f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
      g. Top surfaces of grating sections adjacent to each other shall lie in same plane.
   2. Aluminum grating:
      a. Aluminum grating: Support on aluminum shelf angles or rebates.
   3. Heavy-duty steel grating:
      a. Support on hot-dip galvanized structural steel rebates embedded and anchored in concrete.
      b. Use for roadways, traffic areas, and where indicated on the Drawings.
E. Stainless Steel:
   1. Welding:
      a. Passivate field-welded surfaces:
         1) Provide cleaning, pickling and passivating as specified in this Section.
         2) Clean using Derustit Stainless Steel Cleaner, or equal.

END OF SECTION
SECTION 07_19_00
WATER REPELLENTS

PART 1 GENERAL

1.01 SUMMARY
A. Section includes: Water repellent for concrete for sump pump pit, truck scale pit, sign and masonry for sign.

1.02 REFERENCES
A. International Union of Testing and Research Laboratories for Materials and Structures:
   1. RILEM Test Method No. 11.4 - Measurement of Water Absorption Under Low Pressure.

1.03 DEFINITIONS
A. Water Repellent: Resistance to penetration of water from rainfall.

1.04 SUBMITTALS
A. Product Data.
B. Samples: Water repellent applied on 8-inch by 8-inch substrates to receive water repellent, marked with application date and application rate.
C. Manufacturer's Application Instructions.

1.05 QUALITY ASSURANCE
A. Manufacturer qualifications: Manufacturer of water repellents for minimum of 5 years with satisfactory performance record.
B. Applicator qualifications: Trained, approved, and accepted by water repellent manufacturer.
C. Spray personnel qualifications: Minimum 2 years of experience spraying exotic coatings.
D. Regulatory requirements: Comply with volatile organic compound regulations.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to site in manufacturer's original containers with seals unbroken and labeled with manufacturer's batch number.
B. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.
1.07 ENVIRONMENTAL REQUIREMENTS
   A. Apply water repellent under temperature and relative humidity conditions before, during, and after application in accordance with manufacturer’s instructions.
   B. Allow surfaces to dry for minimum 5 days after rains.

1.08 PROJECT CONDITIONS
   A. Make proper material allowance based upon substrate material and surface configuration when determining quantities of material.

1.09 WARRANTY
   A. Warrant to furnish and apply water repellent on walls that experience water penetration because of failure of water repellent for minimum 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Water repellent sealer:
      1. One of the following or equal:
         a. Rainguard Products.
         b. ProSoCo, Inc.

2.02 DESIGN AND PERFORMANCE CRITERIA
   A. Performance requirements: Surfaces with water repellent shall be uniform in color with unaltered texture.

2.03 MATERIALS
   A. Water repellent sealer for concrete and concrete masonry: Silane/siloxane; volatile organic compound compliant; free of silicone oils, paraffin wax, or urethanes.
      1. Manufacturers: The following or equal:
         a. Rainguard, Blok-Lok™.

   B. Water repellent sealer for concrete exposed aggregate, and cement plaster: Silane/siloxane; volatile organic compound compliant; free of silicone oils, paraffin wax, or urethanes.
      1. Manufacturers: The following or equal:
         a. Rainguard, REGULAR.

   C. Water repellent sealer for brick, clay brick tile, brick veneer, stone, and wood: Silane/siloxane; volatile organic compound compliant; free of silicone oils, paraffin wax, or urethanes.
      1. Manufacturers: The following or equal:
         a. Rainguard, STD-E.
2.04 EQUIPMENT

A. Spray equipment: High-volume, low-pressure, airless, with maximum 60 pounds per square inch pressure:
   1. Pump: Non-atomizing, able to flow material on walls at minimum 1 to 1-1/2 gallons per minute.
   2. Orifice size for concrete, slump block, exposed concrete aggregate, and cement plaster: 0.060 to 0.110 inches.
   3. Orifice size for brick, clay brick tile, brick veneer, stone, and wood: 0.060 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Carefully inspect installed construction. Verify that construction is ready for repellent application.

B. Require manufacturer's representative to verify that water repellent may be installed.

3.02 PREPARATION

A. Allow concrete or masonry walls to cure at least 30 days before applying water repellent.

B. Clean wall surfaces of soil, mud, efflorescence, or other detrimental materials.

C. Tuck-point or caulk cracks, other than hairline cracks.

D. Route out defective mortar joints, point with mortar and tool.

E. Moisture content: Apply water repellent sealer when moisture content of substrate is 15 percent or less.

3.03 APPLICATION ON CONCRETE, CONCRETE MASONRY, EXPOSED CONCRETE AGGREGATE, AND CEMENT PLASTER

A. Apply water repellent in accordance with manufacturer's printed instructions.

B. Apply flood coat using low-pressure spray equipment.

C. Start at top of wall and work down using overlapping horizontal passes.

D. Hold spray head 8 to 10 inches from surface so saturation coat runs freely down wall 6 to 10 inches below point of application on most substrates.

E. Spray by traveling horizontally to ensure uniform coverage.

F. Overlap each following pass by centering spray head on bottom line of the previous pass.
G. Trigger gun off at end of each pass to avoid applying excessive amount of material. Do not over apply.

H. Avoid application in hot or windy weather as premature drying can cause whitish residue on walls.

3.04 APPLICATION ON BRICK, CLAY BRICK TILE, BRICK VENEER, STONE, AND WOOD

A. Apply water repellent in accordance with manufacturer’s printed instructions.

B. Apply wet coat in horizontal passes using low-pressure spray equipment with or without rundown.

C. Overlap each following pass by approximately 50 percent.

D. Trigger gun off at the end of each pass to avoid an excessive amount of material being applied.

E. Keep surface wet for 5 to 10 minutes and damp for over 1 hour.

F. Do not apply in hot or windy weather. Over-application can result in whitish residue on surface.

3.05 FIELD QUALITY CONTROL

A. 20 days after application, test water repellent on CMU surfaces using RILEM Test Method No. 11.4:
   1. Contractor shall perform a 20-minute RILEM baseline test on dry untreated CMU units of each type to receive water repellent. Test results (water loss in milliliter) shall be compared to CMU units in walls after water repellent application.
   2. On water repellent coated CMU, a RILEM tube test resulting in 5 milliliter or less after 20 minutes is necessary to qualify for 5-year warranty.

B. Notify the Engineer and manufacturer at least 72 hours in advance of test.

C. Where tested wall areas fail to pass RILEM tube test, apply additional coat of water repellent on entire wall from corner to corner.

D. Test all locations where directed by the Engineer.

3.06 CLEANING

A. Concrete, concrete masonry, exposed concrete aggregate, and cement plaster: Clean drips, runs, and overspray residue while still wet, using detergent and water. Clean application and spray equipment with detergent and water immediately following use.

B. Brick, clay brick tile, brick veneer, stone, and wood: Clean drips, runs, and overspray residue with petroleum type thinner following application.
C. Clean application and spray equipment according to the manufacturer's recommendations.

D. Remove excess materials, equipment, and debris incidental to water repellent application upon completion.

3.07 PROTECTION

A. During application, protect water repellent treated and adjacent surfaces from damage.

B. Protect glass, aluminum, and other surfaces from overspray.

C. Protect concrete sidewalks from runoff. Soak with water immediately prior to application on adjacent walls.

D. Repair damaged areas promptly.

END OF SECTION
SECTION 10_88_01
INDUSTRIAL WEIGHING SCALES

PART 1  GENERAL

1.01  SUMMARY

A. Section includes: Concrete Deck Truck Scales:
   1. Truck Scale.
   2. Delegated Design of Truck Scale Pit, Sump Pump Pit, and
      Approach/Discharge pads in accordance with Section 01_35_73- Delegated
      Design Procedures.
   3. Delegated Design of Truck Scale Control Cabinet Supports in accordance with
      Section 01_35_73- Delegated Design Procedures.
   4. Weight Indicator, Event Printer.
   5. Enclosure see Section 40_67_01 - Control Systems: Panel, Panel Enclosures
      and Panel Components.

B. Responsibilities of Truck Scale Manufacturer:
   1. Provide truck scale, and manufacturers field services as indicated on the
      drawings and specified herein.
   2. Provide weight indicator and event printer, shipped loose for installation in
      Panel Enclosure provided by the contractor. Install weight indicator
      connections to truck scale load cells and test and commission truck scale as
      specified herein.
   3. Coordinate with Contractor to review enclosure for Weight indicator and Event
      Printer.
   4. Provide the sump pump and vendor control panel for the Truck Scale Pit in
      accordance with Section 43_25_00.10 Submersible Process Liquid Sump
      Pumps. Ship loose for installation by contractor.

C. Responsibilities of Contractor:
   1. Hire a professional engineer and provide a design for Truck Scale Pit, Sump
      Pump Pit, Approach/Discharge Pads, Truck Control Cabinet supports and
      foundation, grounding, and lighting protection as indicated on the drawings
      and specified in Section 01_35_73, Delegated Design Procedures. Coordinate
      with Truck Scale Manufacturer and electrical subcontractor to obtain loads for
      foundation design and Truck Control Cabinet.
   2. Install, test, and commission truck scale, as indicated on the drawings and
      specified herein.
   3. Provide, install, test and commission 120V, 1ph, 60 Hz power to the Truck
      Scale Control Cabinet as indicated on the drawings and specified herein.
   4. Provide, install, test, and commission truck scale control cabinet and
      foundation as indicated on the drawings. Coordinate with Truck Scale
      manufacturer on the design and layout of the Truck Scale Control Cabinet.
   5. Procure materials, install, test, and commission truck scale pit, sump pump pit
      and approach/discharge pads per the design documents provided by the truck
      scale manufacturer as indicated on the drawings and specified in Section
      01_35_73, Delegated Design Procedures.
6. Provide, install, test, and commission 120V, 1ph, 60 Hz power to the sump pump control panel as indicated on the drawings and specified herein.

7. Install, test, and commission the sump pump and control panel as indicated on the drawings and specified in Section 43.25.0010 Submersible Process Liquid Sump Pumps.

8. Procure, install, test, and commission the Sump Pump discharge piping, valves, and appurtenances as indicated on the drawings and specified in Section 43.25.0010 Submersible Process Liquid Sump Pumps.

9. Design electrical grounding and lighting protection system for the truck scale as indicated on the drawings and specified herein.

D. Adjustments to Contract Price and Time: The Truck Scale Installation involves a delegated design of the Truck Scale Pit, Sump pump Pit, Approach/Discharge pads, Truck Scale Cabinet supports and foundation, Electrical grounding, and lightning protection for the truck scale installation. The scope for this work is sufficiently well designed and defined within the contract documents to provide sufficient information for the contractor to establish the costs during bidding. As a result, no claims for changes in the contract price or contract time shall be made relating to this scope of work unless the actual design criteria and conditions are significantly different from those indicated on the drawings and specified in Section 01_35_73 – Delegated Design Procedures. The contractor must provide sufficient evidence of these changes in conditions or criteria with any claims related to the design, procurement, installation, testing, or commissioning of any or all of the delegated design components of the truck scale.

1.02 REFERENCES

A. National Electrical Code (NEC).

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

C. National Institute of Standards and Technology (NIST):

1.03 SUBMITTALS

A. Product data: Submit Manufacturer’s Data.

B. Delegated Design Calculations – Truck Scale Pit:
   1. Submit Professional Engineer stamped and signed calculations for the foundation design, structural concrete reinforcement design, and anchor bolt design of the truck scale pit, sump pump pit, approach/discharge pads, and Truck Scale Control Cabinet foundation and supports as indicated on the drawings and specified in Section 01_35_73 Delegated Design Procedures.

C. Delegated Design Structural Shop drawings – Truck Scale Pit, Sump Pump Pit, Approach/Discharge Pads:
   1. Submit detailed, scaled, structural drawings of the Truck Scale Pit, Sump Pump Pit, Approach/Discharge Pads.
2. The drawings shall contain the plan and section drawings illustrated in Drawing S-101 with the following:
   a. Location and design of water stops for the sump pump pit.
   b. Location, arrangement and details for concrete reinforcement
   c. Location, arrangement, and details of concrete corners and bar lapping distances conforming to the calculations.
   d. Subgrade preparation and subgrade design as indicated on the drawings and specified herein.
   e. Location, design, size, depth and spacing of anchor bolt connections between truck scale and truck scale pit concrete.
   f. Include the thickness of the concrete conforming to the minimum thicknesses indicated on drawing S-101.

D. Delegated Design Geotechnical Investigations and Reports.
   1. Any geotechnical information and reports utilized as a basis for design professionals' calculations associated with Truck Scale Pit and Truck Scale Control Cabinet Supports as referenced in Section 01_35_73 Delegated Design Procedures.

E. Vendor operation and maintenance manuals.

F. Truck Scale Control Cabinet: Provide a control panel hardware submittal for the truck scale cabinet including but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
   2. Shop drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
         2) Shall include Truck Scale Controller, Printer and other items indicated on the drawings.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
      d. Structural drawings of Metal Fabrications for Panel Support.
   3. Delegated Design Calculations:
      a. Cooling calculations, including but not limited to:
         1) Highest expected ambient temperature for the enclosure's location.
         2) Internal heat load.
         3) Exposure to direct sunlight.
         4) Dimensions of the enclosure in inches.
         5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.
      b. Structural supports for Truck Scale Control Cabinet:
         1) Provide design calculations related to metal fabrications for the Panel Support as specified in Section 01_35_73 Delegated Design Procedures.
c. Structural pad for Truck Scale Control Cabinet:
   1) Provide structural and reinforcement design for truck scale control
cabinet foundations as indicated on the drawings and specified in
Section 01_35_73 Delegated Design Procedures

G. Delegated Design Submittals – Electrical Equipment, Grounding, and Lightning
   protection:
   1. Anchoring and bracing: Provide project-specific calculations based on support
      conditions and requirements to resist loads specified in Section 01_35_73
      Delegated Design Procedures.
      a. To structures for equipment installed in structures designated as seismic
         design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.
   2. Grounding Design: Provide shop drawings indicating location and sizing of the
      grounding elements and connecting wire sizes.
   3. Lightning Protection Design: Provide shop drawings indicating location and
      sizing of the lightning protection system associated with the truck scale.

1.04 REGULATORY REQUIREMENTS

A. The scale system shall conform to the following federal, state, local, and industrial
   standards:
   1. NIST Handbook 44.
   2. NEMA and the NEC.

1.05 WARRANTY

A. Provide 10-year manufacturer’s warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   2. Toledo Scale.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Each truck scale shall be a fully electronic, pit type, having a 50-ton minimum
      capacity and a 80,000-pound tandem axle capacity, with a reinforced concrete
      weigh bridge 80 feet long by 11 feet wide.
   2. Each scale shall be complete with weigh bridge, load cells, splice boxes,
      electronics with digital indicator, and all instrumentation, printer, electrical, and
      other accessories required for a complete operational unit.
   3. The weigh bridge shall consist of structural steel beams and cross members,
      and a welded steel frame reinforced concrete deck.
   4. The system shall consist of multiple load cells that are environmentally sealed,
      rocker pin or double link style suspension system, corrosion-resistant anchor
bolts, assembly fasteners, and all appurtenances necessary for complete assembly.

5. Load cells:
   a. Load cells shall be strain gauge type, specially sealed, in accordance with manufacturer's recommendations for continuous operation in an environment containing trace quantities of chlorine gas.

6. Load cell parameters shall not exceed the following:

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<th>Calibration Accuracy</th>
<th>0.1 percent Rated Output</th>
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<td>Nonlinearity</td>
<td>0.05 percent Full Scale</td>
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<tr>
<td>Creep</td>
<td>0.03 percent Full Scale</td>
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<tr>
<td>Temperature Effect</td>
<td>0.0008 percent Full Scale/Degrees Fahrenheit</td>
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<tr>
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<tr>
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2.03 DELEGATED DESIGNS

A. See Section 01_35_73 Delegated Design Procedures for Manufacturers requirements for the design of the Truck Scale Pit, Sump Pump Pit, and Approach/Discharge Pads.

B. See Section 01_35_73 Delegated Design Procedures for Manufacturers requirements for the design of the Truck Control Cabinet Supports and Foundation.

C. See Section 01_35_73 Delegated Design Procedures for Manufacturers requirements for the design of the Lighting protection and electrical grounding system for the Truck Scale.

2.04 TRUCK SCALES

A. Provide rough-in hardware, supports, connections, attachments, and other accessories required for complete installation.

B. Electrical requirements:
   1. Power supply:
      a. Unless otherwise specified, the power supply to the equipment shall be 120 volts, single phase, 60 hertz.
      b. Where control voltages lower than the power supply voltage is required, suitable control power transformers shall be furnished.
   2. Lightning protection: Lightning protection for each scale system shall be provided to protect the load cells, instrumentation, and power supply.
   3. Grounding: Bare 1/0 copper grounding conductors shall be furnished and installed from the scales to the ground grid or to a ground rod furnished for the grounding electrode system as required by the equipment furnished.
2.05 ACCESSORIES

A. Instrumentation accessories for the truck scale shall consist of a digital readout indicator, scale terminal, event printer, and all cable, conduit, hookups, and appurtenances necessary to make the scale system operational.

B. Scale Terminal:
   1. Communication methodology / protocol between the weight indicator, printer, plant control system and any other peripheral devices shall be approved by the TMUA.
   2. Processor shall be a 1.6 GHz processor minimum.
   3. Memory shall be 1 GB Ram.
   4. Minimum Four USB Port externally accessible.
   5. Instrument shall be accessible through a standard PC browser using standard ethernet interface.
   6. Dedicated 20 mA interface for remote displays. Interface shall support both active and passive remote displays.
   7. The instrument display shall be full color graphics display:
      a. Display shall have 6-digit indication in maximum 20-pound increments.
      b. Display shall be an active matrix with tough screen.
   9. Scale Terminal shall have a zero lock key switch, "power on" LED indication, and continuous weigh mode.
   10. Automatic tare control shall allow both gross and net weight indication.
   11. Unit shall operate on 120-volt, single-phase power and shall include a surge voltage protection system.
   12. Enclosure: The Scale Terminal shall be housed in a NEMA Type 4X heated and cooled enclosure Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.
   13. Remote weight indication: Provide a 4-20 mA direct current output signal for remote weight indication and provide a low weight alarm contact for remote indication.

C. Scale Instrument Function:
   1. The scale instrument shall be a self-contained, operating unit providing a digital weight.
   2. The instrument shall be driven by appropriate control circuitry.
   3. The scale shall provide a directly printed certified weight ticket.

D. Event Printer:
   1. Printer shall receive and record weigh events from the scale terminal.
   2. Unit shall operate on 120 v supply.
   3. Provide a minimum of 6 months ink and paper.
   4. Printer to be mounted in the Enclosure with the Scale Terminal.

2.06 FABRICATION

A. Factory finish all ferrous metal with manufacturer's standard paint finish.

B. Field touch-up painting of damaged surfaces, per manufacturer's requirements.

C. Anchor bolts: Stainless Steel.
PART 3  EXECUTION

3.01  INSTALLATION

A. After the concrete support structures have reached their design strength, the Contractor shall install the scale system, level, balance, and grout in place the structural members as required by the manufacturer's recommendation.

B. Mount the weight indicating transmitter and event printer in the enclosure next to the scale.

C. Do not grout in the base and leveling plates until all adjusting calibration work has been done.

3.02  CERTIFICATION

A. Provide the required scale certification for capacity and accuracy as required by authorities having jurisdiction.

3.03  ADJUSTING

A. Adjust components for smooth, even operation, free from binding.

3.04  DEMONSTRATION

A. Demonstrate operation of scales to Owner-designated personnel.

3.05  COMMISSIONING

A. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. Installation: 2 trips, 3 day minimum each.
      b. Functional Testing: 2 trips, 3 day minimum each.
      c. Training: 1 trip, 3 day minimum each
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.

B. Source testing:
   a. Test as specified Test witnessing: Not witnessed.
   b. Conduct Level 1 General Equipment Performance Test.

C. Functional testing:
   1. Scale:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
      c. Perform running speed test with full maximum load to verify installed equipment meets specified requirements.
      d. Provide the required scale certification for capacity and accuracy to the Engineer as required by the authorizing agency.
2. Electrical Instrumentation and Controls:
   a. Test witnessing: Witnessed.
   b. The Contractor shall provide 2 weights for testing at 10-ton and at 30-ton and calibrate the net and gross weight readouts.

END OF SECTION
SECTION 26_05_00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. General requirements applicable to all Electrical Work.

2. General requirements for electrical submittals.

3. Interfaces to equipment, instruments, and other components;

4. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.

5. Provide all material and labor needed to install the actual equipment furnished, and include all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the Work, which may be necessary to make a complete, functional installation based on the actual equipment furnished:

   a. Make all changes necessary to meet the manufacturer’s wiring requirements.

   b. Submit all such changes and additions to the Engineer for acceptance.

6. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appear on the Drawings or in the Specifications from another discipline in the scope of Work:

   a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.

7. Loop drawings:

   a. Provide all electrical information required in the preparation of loop drawings including, but not limited to:

      1) Conduit numbers and associated signal(s) contained within each conduit.

      2) Wire numbers.

      3) Equipment terminal numbers.

      4) Junction boxes and signal(s) contained within each junction box.

      5) Equipment power sources, and associated circuit numbers.

      6) As-built drawings detailing wiring.
B. All electrical equipment and systems for the entire Project must comply with the requirements of the Electrical Specifications, whether referenced in the individual Equipment Specifications or not:

1. The requirements of the Electrical Specifications apply to all Electrical Work specified in other sections.

2. Inform all vendors supplying electrical equipment or systems of the requirements of the Electrical Specifications.

3. Owner is not responsible for any additional costs due to the failure of Contractor to notify all subcontractors and suppliers of the Electrical Specifications requirements.

C. Contract Documents:

1. General:

   a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.

2. Specifications:

   a. The General and Supplementary Conditions of the Contract Documents govern the Work.

   b. These requirements are in addition to all General Requirements.

3. Contract Drawings:

   a. The Electrical Drawings show desired locations, arrangements, and components of the Electrical Work in a diagrammatic manner.

   b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only; exercise professional judgment in executing the Work to ensure the best possible installation.

   c. The equipment locations and dimensions indicated on the Drawings are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.

   d. The Contractor has the freedom to select any of the named manufacturers identified in the individual specification sections; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer’s equipment fits in the allotted space. It is the Contractor’s responsibility to ensure that the equipment being furnished fits within the defined space.

   e. Installation details:

      1) The Contract Drawings include typical installation details the Contractor is to use to complete the Electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.

      2) Not all typical installation details are referenced within the Drawing set. Apply and use typical details where appropriate.
4. Schematic diagrams:
   a. All controls are shown de-energized.
   b. Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
   c. Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
   d. Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
   e. Schematic diagrams are to be used in conjunction with the descriptive operating sequences in the Contract Documents. Combine all information and furnish a coordinated and fully functional control system.

1.2 REFERENCES

A. Code compliance:

1. As specified in the section for Regulatory Requirements.

   The publications are referred to in the text by the basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of the bid governs.

2. The standards listed are hereby incorporated into this Section.

   b. American Society of Civil Engineers (ASCE):
   d. ASTM International (ASTM).
   e. Illuminating Engineering Society (IES).
   f. Institute of Electrical and Electronics Engineers (IEEE).
   g. Insulated Cable Engineers Association (ICEA).
   h. International Code Council (ICC):
   j. AC 156 - Acceptance Criteria for Seismic Certification by Shake Table Testing of Non-Structural Components (ICC-ES AC 156).
   k. International Society of Automation (ISA).
   l. National Electrical Manufacturers Association (NEMA):
   m. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
   n. National Fire Protection Association (NFPA):
   o. 70 - National Electrical Code (NEC).
   q. Underwriters' Laboratories, Inc. (UL).
   r. Compliance with laws and regulations: As specified in Document 00700 - General Conditions.
1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth by:

1. IEEE.
2. NETA.
3. IES.
4. ISA.
5. NEC.
6. NEMA.
7. NFPA.
8. NIST.
9. Specific definitions:
10. FAT: Factory acceptance test.
11. LCS: Local Control Station
12. ICSC: Instrumentation and controls subcontractor.
13. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
14. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
15. PCIS: Process control and instrumentation system.
16. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
17. Space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment, i.e., provide all standoffs, bus, and hardware, as part of the space.
18. Spare: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that physically contains a device with no load connections to be made.
19. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
20. Unequipped space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.
1.4 SYSTEM DESCRIPTION

A. General requirements:

1. The Work includes everything necessary for and incidental to executing and completing the Electrical Work indicated on the Drawings and specified in the Specifications and reasonably inferable there from:
   a. The Electrical Drawings are schematic in nature; use the Structural, Architectural, Mechanical, and Civil Drawings for all dimensions and scaling purposes.

2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of equipment furnished by others as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.

3. Provide all Electrical Work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the Work.

4. Coordinate all aspects of the Work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the electrical subcontractor, the other subcontractors or suppliers.

5. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
   a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
   b. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.
   c. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the Electrical Work and installation:

      1) As specified in the Contract Documents.

1.5 SUBMITTALS

A. General:

1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.

2. Furnish the submittals required by each section in the Electrical Specifications.

3. Adhere to the wiring numbering scheme specified in the section for Identification for Electrical Systems throughout the Project:

4. Uniquely number each wire.

5. Wire numbers must appear on all Equipment Drawings.

6. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.
B. Seismic requirements:

1. Provide electrical equipment with construction and anchorage to supporting structures
designed to resist site seismic loads based on the seismic design criteria in
Specifications.

2. For equipment installed in structures designated as seismic design category C, D, E or
F, prepare and submit the following:

   a. Statement of seismic qualification, and special seismic certification:

      1) "Statement of seismic qualification:" Provide manufacturer's statement that
         the equipment satisfies the seismic design requirements of the building code
         indicated in the section for Regulatory Requirements, including the
         requirements of ASCE 7, Chapter 13.

      2) "Special seismic certification:" Provide manufacturer's certification that the
         equipment, when subjected to shake table testing in accordance with ICC-
         ES AC 156, meets the "Post-Test Functional Compliance Verification"
         requirements of ICC-ES AC 156 for "Components with Ip = 1.5." Compliance
         shall include both operability and containment of hazardous materials as
         appropriate to the unit being tested.

   b. Substantiating test data: With seismic qualification and special seismic certification
      statements, submit results of testing in accordance with ICC-ES AC 156.

   c. Anchoring design calculations and details:

      1) Submit project-specific drawings and supporting calculations, prepared and
         sealed by a professional engineer licensed in the state where the Project is
         being constructed, and showing details for anchoring electrical equipment to
         its supports and for anchoring supports provided with the equipment to the
         structure. Prepare calculations in accordance with the requirements of the
         section for Seismic Design Criteria.

      2) Exemptions: A "statement of seismic qualification" and a "special seismic
         certification" are not required for the following equipment:

   d. Temporary or moveable equipment.

      1) Equipment anchored to the structure and having a total weight of 20 pounds
         or less.

      2) Distribution equipment anchored to the structure and having a total unit
         weight of 3 pounds per linear foot, or less.

C. Submittal organization:

1. First page:


   b. Name and telephone number of individual who reviewed submittal before delivery
to Engineer.

   c. Name and telephone number of individual who is primarily responsible for the
development of the submittal.

   d. Place for Contractor's review stamp and comments.

2. Next pages:

   a. Provide confirmation of specification compliance:

      1) Specification section: Include with each submittal a copy of the relevant
         specification section.
2) Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).

3) Provide a list of all numbered deviations with a clear explanation and reason for the deviation.

b. Include a response in writing to each of the Engineer’s comments or questions for submittal packages which are re-submitted:
   1) In the order that the comments or questions were presented throughout the submittal.
   2) Referenced by index section and page number on which the comment appeared.

c. Acceptable responses to Engineer’s comments are either:
   1) Engineer’s comment or change is accepted and appropriate changes are made.
   2) Explain why comment is not accepted or requested change is not made.
   3) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.

d. Any re-submittal, which does not contain responses to the Engineer’s previous comments shall be returned for Revision and Re-submittal.

e. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Remaining pages:
   a. Actual submittal data:
      1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
      2) For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.

D. Submittal requirements:
   1. Furnish submittals that are fully indexed with a tabbed divider for every component.
   2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
   3. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.
   4. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
   5. Submit copies of shop drawings, and product data:
      a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
   6. Where submittals are required, provide a separate submittal for each specification section. In order to expedite construction, the Contractor may make more than 1
submittal per specification section, but a single submittal may not cover more than 1 specification section:

a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section. (For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.)

7. Exceptions to Specifications and Drawings:

a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.

b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.

c. Acceptance of any exception is at the sole discretion of the Engineer.

d. Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.

e. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.

8. Specific submittal requirements:

a. Shop drawings:

1) Required for materials and equipment listed in this and other sections.

2) Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.

3) Shop drawings requirements:

a) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.

b) Locations of conduit entrances and access plates.

c) Component layout and identification.

d) Schematic and wiring diagrams with wire numbers and terminal identification.

e) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.

f) Anchoring method and leveling criteria, including manufacturer’s recommendations for the Project site seismic criteria.

g) Weight.

h) Finish.

b. Nameplates:

1) As specified in the section for Identification for Electrical Systems.

2) Temperature limitations, as applicable.

c. Product data:

1) Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
2) Include:
   a) Catalog cuts.
   b) Bulletins.
   c) Brochures.
   d) Quality photocopies of applicable pages from these documents.
   e) Identify on the data sheets the Project name, applicable specification section, and paragraph.
   f) Identify model number and options for the actual equipment being furnished.
   g) Neatly cross out options that do not apply or equipment not intended to be supplied.
   h) Detailed sequence of operation for all equipment or systems.

E. Operation and maintenance manuals:
   1. As specified in the section for Operation and Maintenance Data.
   2. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.

F. Material and equipment schedules:
   1. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
   2. Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

G. Schedule of values:
   1. In addition to completing all items referred to in the schedule of values, submit per unit material and labor costs used in developing the final bid for the electrical system, for the express purpose of pricing and cost justification for any proposed change orders. In addition to the items shown on the schedule of values, provide per unit material and labor costs for conduit and wire installation for specific types, sizes, and locations as indicated on the Drawings. It is the responsibility of the electrical subcontractor to prove to the Engineer’s satisfaction that said per unit costs were used in the development of the final Bid amount.

H. Roof penetrations:
   1. Submit details of all portions of the electrical installation that penetrate the roof. Include details showing support of the penetrating component, and the sealing means to be utilized.

I. Record Documents:
   1. Provide Record Documents of all Electrical Drawings.
   2. Record Drawing requirements:
      a) Update Record Drawings weekly.
      b) Record Drawings must be fully updated as a condition of the monthly progress payments.
      c) Submit Record Drawings upon completion of the Work for final review.
d. Clearly and neatly show all changes including the following:
   1) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.

3. Shop drawings:
   a. Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
   b. Provide as-built shop drawings for all electrical equipment on 11-inch by 17-inch paper.
   c. Size all drawings to be readable and legible on 11-17-inch media.
   d. Provide electronic copies of these documents on CD-ROM or DVD disks in PDF format.

4. Review and corrections:
   a. Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
   b. Promptly correct and re-submit record documents returned for correction.

J. Test reports:
   1. Include the following:
      a. A description of the test.
      b. List of equipment used.
      c. Name of the person conducting the test.
      d. Date and time the test was conducted.
      e. All raw data collected.
      f. Calculated results.
   2. Each report signed by the person responsible for the test.
   3. Additional requirements for field acceptance test reports are specified in the section for Field Electrical Acceptance Tests.

K. Calculations:
   1. Where required by specific Electrical Specifications:
      a. Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

1.6 QUALITY ASSURANCE

A. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the section for Product Requirements.

B. Shipping precautions:
   1. After completion of shop assembly and successful factory testing, pack all equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
2. Place dehumidifiers, when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

C. Delivery and inspection:
   1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.

D. Special instructions:
   1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

1.8 PROJECT OR SITE CONDITIONS

A. Site conditions:
   1. Provide an electrical, instrumentation and control system, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.

   2. Seismic load resistance:
      a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads as specified in Specifications.

   3. Wind load resistance:
      a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads as specified in Specifications.

   4. Altitude, temperature and humidity:
      a. As specified in Specifications.
      b. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
      c. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer's guidelines.
      d. Provide all power conduits wiring for these devices (e.g. heaters, fans, etc.) whether indicated on the Drawings or not.

   5. Outdoor installations:
      a. Provide electrical, instrumentation and control equipment suitable for operation in the ambient conditions where the equipment is located.
      b. Provide heating, cooling, and dehumidifying devices incorporated into and included with electrical equipment, instrumentation and control panels to maintain the enclosures within the rated environmental operating ranges as specified in this Section for the equipment.
      c. Provide all wiring necessary to power these devices.
d. Provide enclosures for electrical, instrumentation and control equipment, regardless of supplier or subcontractor furnishing the equipment, that meet the requirements outlined in NEMA Standard 250 for the following types of enclosures:

1) NEMA Type 1: Intended for indoor use, primarily to provide a degree of protection from accidental contact with energized parts or equipment.

2) NEMA Type 4X: Made from corrosion resistant materials and are intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing.

3) NEMA Type 4X: Made from corrosion resistant materials and are intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing, and corrosion. Provide specific materials as specified or indicated on the Drawings.

4) NEMA Type 12: Intended for indoor use, primarily to provide a degree of protection from dust, falling dirt and dripping non-corrosive liquids.

5) NEMA Type 7: Intended for installation in locations where explosive or combustible gas or vapors may be present (Class I Division 1 or Class I Division 2) meeting the requirements outlined in the section for Hazardous Classified Area Construction.

6. Plant area Electrical Work requirements:

a. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

<table>
<thead>
<tr>
<th>PLANT AREA</th>
<th>NEMA ENCLOSURE TYPE</th>
<th>EXPOSED CONDUIT TYPE</th>
<th>ENVIRONMENT</th>
<th>SUPPORT MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Conditioned Spaces</td>
<td>NEMA 12</td>
<td>Galvanized rigid steel</td>
<td>C</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Indoor Unconditioned Spaces</td>
<td>NEMA 12</td>
<td>Galvanized rigid steel</td>
<td>D</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Chemical Rooms</td>
<td>NEMA 4X</td>
<td>PVC Coated galvanized rigid steel</td>
<td>X</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Lighting, switch, and receptacle circuits exposed above hung ceilings or concealed in partition walls</td>
<td>NEMA 1</td>
<td>¾&quot; or 1&quot; – EMT Above 1&quot; Galvanized rigid steel</td>
<td>C</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>PLANT AREA</td>
<td>NEMA ENCLOSURE TYPE</td>
<td>EXPOSED CONDUIT TYPE</td>
<td>ENVIRONMENT MATERIALS</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>Outdoor</td>
<td>NEMA 3R</td>
<td>Galvanized rigid steel</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stainless steel</td>
<td></td>
</tr>
<tr>
<td>Below grade vaults</td>
<td>NEMA 4X</td>
<td>Galvanized rigid steel</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stainless steel</td>
<td></td>
</tr>
</tbody>
</table>

Modify exposed conduit runs as specified in the section for Conduits.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
   1. Testing requirements are specified in the section for Field Electrical Acceptance Tests and other sections.

B. Pre-submittal conference:
   1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire Project, equipment, control philosophy, schedules, and submittal requirements.
   2. Contractor, electrical subcontractor, all suppliers, and individual equipment manufacturers furnishing major pieces of equipment must attend.

C. Factory acceptance testing (FAT):
   1. Where FAT is required for equipment covered by these Specifications, notify the Engineer in writing when the equipment is completed and ready for factory inspection and testing:
   2. Indicate the desired dates for inspection and testing.
   3. Schedule the FAT after approval of the FAT procedures submittal:
      a. Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
      b. Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

1.11 WARRANTY

A. Warrant the Electrical Work as specified in General Conditions:
B. Provide additional warranty as specified in the individual Electrical Specifications.

1.12 SYSTEM START-UP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
B. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.
1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide similar items of same manufacturer throughout the electrical and instrumentation portion of the Project.

B. Allowable manufacturers are specified in individual Electrical Specifications.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS

A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard as specified in General Conditions.

C. Stainless steel:

1. Where stainless steel is indicated or used for any portion of the Electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.

2. Provide exposed screws of the same alloys.

3. Provide finished material free of any burrs or sharp edges.

4. Use only stainless steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals.

5. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.

6. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)
2.11 SOURCE QUALITY CONTROL
A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products.

PART 3 - EXECUTION

3.1 EXAMINATION
A. The electrical subcontractor is encouraged to visit the site to examine the premises completely before bidding.
B. Review the site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.
C. It is the electrical subcontractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations.
D. Comply with pre-bid conference requirements as specified in Instructions to Bidders.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION
A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
B. Verify all dimensions indicated on the Drawings:
   1. Actual field conditions govern all final installed locations, distances, and levels.
C. Review all Contract Documents and approved equipment shop drawings and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
D. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
E. Provide a complete electrical system:
   1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical system.
   2. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
F. Cutting and patching:
   1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
   2. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member such as drilling, cutting or piercing:
   3. Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made:
      a. Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables, etc.
      b. Use tone-locate system or X-ray to ensure that area is clear of obstructions.
      c. Review the complete Drawing set to ensure that there are no conflicts or coordination problems before cutting, channeling, or core drilling any surface.
4. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:
   a. 3M: CP 25WB+: Caulk.
   b. 3M: Fire Barrier: Putty.

5. Install all conduits and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
   a. Install all conduits and equipment in accordance with working space requirements in accordance with the NEC.
   b. This includes any panel, disconnect switch or other equipment that can be energized while open exposing live parts regardless of whether it is likely to require examination or has serviceable parts.
   c. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings.
   d. Adjust equipment locations as necessary to avoid any obstruction or interferences.
   e. Where an obstruction interferes with equipment operation or safe access, relocate the equipment.
   f. Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.

G. Earthwork and concrete:
   1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the Electrical Work:
      a. Requirements as specified in the Contract Documents.

H. Roof penetrations:
   1. Seal conduit penetrations in accordance with roofing manufacturer’s instructions.

I. Terminations:
   1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.

J. Miscellaneous installation requirements:
   1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer as specified in General Conditions.
   2. Location of manholes and pullboxes indicated on the Drawings are approximate. Coordinate exact location of manholes and pullboxes with Mechanical and Civil Work.
   3. Provide additional manholes or pullboxes to those shown where they are required to make a workable installation.
   4. Circuits of different service voltage:
      a. Voltage and service levels:
      b. Medium voltage: greater than 1.0 kV.
      c. Low voltage: 120 V to 480 V.
      d. Instrumentation: Less than 50 VDC.
e. Install different service voltage circuits in separate raceways, and junction boxes.

5. In manholes, install all cables operating at less than 50 VDC in PVC coated flexible metallic conduit, with corrosion resistant fittings.

6. Labeling:

K. Equipment tie-downs:

1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing criteria, which apply to the Site.

2. **ALL CONTROL PANELS MUST BE PERMANENTLY MOUNTED AND TIED DOWN TO STRUCTURES IN ACCORDANCE WITH THE PROJECT SEISMIC CRITERIA.**

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 FIELD QUALITY CONTROL

A. Inspection:

1. Provide any assistance necessary to support inspection activities.

2. Engineer inspections may include, but are not limited to, the following:

3. Inspect equipment and materials for physical damage.

4. Inspect installation for compliance with the Drawings and Specifications.

5. Inspect installation for obstructions and adequate clearances around equipment.

6. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.

7. Inspect equipment nameplate data to verify compliance with design requirements.

8. Inspect raceway installation for quality workmanship and adequate support.

9. Inspect cable terminations.

10. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in the section for Field Electrical Acceptance Tests.

B. Field acceptance testing (Functional Testing):

1. Notify the Engineer when the Electrical Work is ready for field acceptance testing.

2. Perform the field acceptance tests as specified in the section for Field Electrical Acceptance Tests.

3. Record results of the required tests along with the date of test:

4. Use conduit identification numbers to indicate portion of circuit tested.

C. Workmanship:

1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:

2. Neatly coil and label spare wiring lengths.

3. Shorten, re-terminate, and re-label excessive used as well as spare wire and cable lengths, as determined by the Engineer.
3.8 ADJUSTING (NOT USED)

3.9 CLEANING
   A. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
   B. Clean and vacuum all enclosures to remove all metal filings, surplus insulation and any visible dirt, dust or other matter before energization of the equipment or system start-up.
   C. Use of compressors or air blowers for cleaning is not acceptable.
   D. As specified in other sections of the Contract Documents.

3.10 PROTECTION
   A. Protect all Work from damage or degradation until Substantial Completion.
   B. Maintain all surfaces to be painted in a clean and smooth condition.

3.11 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_06_00
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Grounding materials and requirements.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical.

B. ASTM International (ASTM):

C. Institute of Electrical and Electronics Engineers (IEEE):

D. Underwriters Laboratories, Inc. (UL):
   1. 467 - Ground and Bonding Equipment.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

1.4 SUBMITTALS

A. Furnish submittals as specified in the Submittal Procedures section and the Common Work Results for Electrical section.

B. Product data:
   1. Catalog cut sheets.

1.5 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. All grounding components and materials shall be UL listed and labeled.

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.
1.7 PROJECT/SITE CONDITIONS (NOT USED)

1.8 SEQUENCING (NOT USED)

1.9 SCHEDULING (NOT USED)

1.10 WARRANTY

A. As specified in the Common Work Results for Electrical.

1.11 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE (NOT USED)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Exothermic connectors: One of the following or equal:
   1. Erica.
   2. Harger.
   3. Burndy.
   4. Thomas & Betts.

B. Ground rods: One of the following or equal:
   1. Erica.
   2. Harger.
   3. Nehring.
   4. Thomas & Betts.

C. Ground cable: One of the following or equal:
   1. Erica.
   2. Harger.
   3. Nehring.
   4. Southwire.

D. Precast ground well boxes: One of the following or equal:
   1. Brooks Products, 3-RT Valve Box.
   2. Christy Concrete Products, G12 Valve Box.

2.2 SYSTEM DESCRIPTION

A. Ground equipment and raceway systems so that the completed installation conforms to all applicable code requirements.

B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
   1. Grounding electrodes.
   2. Bonding jumpers.
C. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

D. The ground system resistance (electrode to ground) of the completed installation, as determined by tests specified in Section 16950 - Field Electrical Acceptance Tests, shall be:
   1. 5 ohms or less for industrial systems.

2.3 EXISTING PRODUCTS (NOT USED)

2.4 MATERIALS

A. Ground rod:
   1. Minimum 3/4-inch diameter, 10 feet long.
   2. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core:
      a. The copper-to-steel bond shall be corrosion resistant.
      b. In accordance with UL 467.
   4. Sectional type joined by threaded copper alloy couplings.
   5. Fit the top of the rod with a threaded coupling and steel-driving stud.

B. Ground cable:
   1. Requirements:
      a. Soft drawn (annealed).
      b. Concentric lay, coarse stranded in accordance with ASTM B8.
   2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. Exothermic welds:
   1. Current carrying capacity equal to that of the conductor.
   2. Permanent molecular bond that cannot loosen or corrode over time.
   3. Will not deteriorate with age.
   4. Use low emission welds for indoor installations.

D. Equipment grounding conductors:
   1. Conductors shall be the same type and insulation as the load circuit conductors:
      a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
   2. Minimum size in accordance with the NEC.

E. Grounding electrode conductors:
   1. Minimum size in accordance with the NEC.

F. Main bonding jumpers and bonding jumpers:
   1. Minimum size in accordance with the NEC.

2.5 MANUFACTURED UNITS (NOT USED)

2.6 EQUIPMENT (NOT USED)

2.7 COMPONENTS (NOT USED)

2.8 ACCESSORIES

A. Precast ground well boxes:
   1. Minimum 10-inch interior diameter.
   2. Traffic-rated cast iron cover.
3. Permanent “GROUND” marking on cover.

2.9 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
   1. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.
   2. Provide a separate grounding conductor in each individual raceway for parallel feeders.

C. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
   1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

D. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
   1. Individually bond these raceways to the ground bus in the equipment.

E. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.

F. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

G. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.

H. Duct bank ground system:
   1. Provide a bare copper grounding conductor the entire length of each duct bank.
   2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.

I. Grounding at service (600 V or Less):
   1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.
J. Ground connections:
   1. All connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using exothermic welds as indicated on the Drawings, UL listed, and labeled for the application.
   2. Make ground connections in accordance with the manufacturer's instructions.

K. Grounding electrode system:
   1. Ground ring:
      a. Provide all trenching and materials necessary to install the ground ring as indicated on the Drawings.
      b. Ground ring conductor shall be in direct contact with the earth.
      c. Minimum burial depth 36 inches or as indicated on the Drawings.
      d. Re-compact disturbed soils to original density in 6-inch lifts.
   2. Ground rods:
      a. Locations as indicated on the Drawings.
      b. Length of rods forming an individual ground array shall be equal in length.
      c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
   3. Metal underground water pipe:
      a. Bond metal underground domestic water pipe to grounding electrode system.
   4. Metal frame of building or structure:
      a. Bond metal frame of building or structure to grounding electrode system.
   5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.
   6. Where grounding conductors are not concrete-encased or direct buried, install in Schedule 40 PVC conduit for protection.
   7. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.

L. Shield grounding:
   1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable run.
   3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
   4. Terminate the signal cable shield on a dedicated grounding terminal block.

M. Where indicated on the Drawings, install ground rods in precast ground wells.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING (NOT USED)

3.8 FIELD QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.
3.9 ADJUSTING

   A. Under the direction of the Engineer, add additional parallel connected ground rods and/or
deeper driven rods until the ground resistance measurement meets the specified resistance
requirements:
   1. Use of salts, water, or compounds to attain the specified ground resistance is not
      acceptable.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

   A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_07_00
HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Mounting and supporting electrical equipment and components.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. ASTM International (ASTM):

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

1.4 SYSTEM DESCRIPTION

A. Design requirements:
   1. Demonstrate the following using generally accepted engineering methods:
      a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
      b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.
   2. Design loading and anchoring requirements:
      a. As indicated in the Building Code unless otherwise specified.
      b. Seismic loading requirements:
         1) Freestanding, suspended, or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in the Common Work Results for Electrical section.
      c. Wind loading requirements:
         1) All exterior equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in the Common Work Results for Electrical section.
      d. Minimum safety factor against overturning: 1.5.
      e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.

B. Performance requirements:
   1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.
1.5 SUBMITTALS

A. Furnish submittals as specified in the Submittal Procedures section and the Common Work Results for Electrical section.

B. Product data:
   1. Supports:
      b. Geometry.
      c. Manufacturer.
   2. Hardware:
      b. Manufacturer.

C. Shop drawings:
   1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
   2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, and wall supports for all equipment:
      a. For free standing supports and wall supports supporting equipment weight in excess of 200 pounds:
         1) Stamped by a professional engineer licensed in the state where the Project is being constructed.
      b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.
   3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.

D. Installation instructions:
   1. Furnish anchorage instructions and requirements based on the seismic and wind conditions of the Site:
      a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.
1.12 SYSTEM STARTUP

A. As specified in the Common Work Results for Electrical section.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
   1. Preformed channel:
      a. Thomas & Betts.
      b. Power-Strut.
      c. Unistrut.
      d. Cooper B-Line.
      e. Robroy.
      f. Tyco.

B. Nonmetallic cable rack:
   1. Underground Devices Inc.
   2. Hubbell.
   3. Unistrut.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS

A. Use materials appropriate for the area as specified in the Common Work Results for Electrical section.

B. Preformed channel:
   1. Stainless steel:
      a. Supports:
         1) In accordance with ASTM A240.
         2) ANSI Type 316 material.
      b. Hardware:
         1) ANSI Type 316 material.

C. Non-metallic cable rack:
   1. Consists of stanchions and cable support arms.
   2. Stanchions:
      a. 50 percent glass reinforced nylon or other non-metallic material.
      b. Capable of supporting multiple arms.
      c. Recessed bolt mounting holes.
      d. Length as required.
   3. Arms:
      a. 50 percent glass reinforced nylon or other non-metallic material.
      b. Size the arms based on the length and weight of the cable to be supported.
   4. Stainless steel mounting hardware.

2.4 MANUFACTURED UNITS (NOT USED)
2.5 EQUIPMENT (NOT USED)
2.6 COMPONENTS (NOT USED)
2.7 ACCESSORIES (NOT USED)
2.8 MIXES (NOT USED)
2.9 FABRICATION (NOT USED)
2.10 FINISHES (NOT USED)
2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION (NOT USED)
3.2 PREPARATION (NOT USED)
3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Preformed Channel:
   1. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
      a. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.
   2. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
      a. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.
   3. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
      a. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
      b. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
      c. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.
   4. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
      1) Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.
   5. Corrosion protection:
      a. Isolate dissimilar metals, except where required for electrical continuity.
      1) Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.
   6. Raceway:
      a. Furnish all racks and trapeze structures needed to support the raceway from the structure.
      1) Group raceway and position on racks to minimize crossovers.
      2) Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.
7. Anchoring methods:
   a. Solid concrete: Anchor bolts, anchor rods or post-installed anchors.
   b. Metal surfaces: Machine screws or bolts.
   c. Hollow masonry units: Post-installed anchors.
8. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.
9. Recoat or seal all drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

C. Non-metallic cable rack:
   1. Install the non-metallic cable rack in accordance with the manufacturer’s recommendations.
   2. Provide at least 2 stanchions and 2 arms at each installation.
   3. Mount the cable rack so that the supported cable does not interfere with access to manhole or handhole and so that the supported cable does not lie on the floor.
   4. Do not exceed the cable manufacturer’s minimum bending radius.
   5. Use nylon cable ties to secure the cable to the supports.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)
3.7 COMMISSIONING (NOT USED)
3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.
3.9 ADJUSTING (NOT USED)
3.10 CLEANING (NOT USED)
3.11 PROTECTION
   A. As specified in the Common Work Results for Electrical section.
3.12 SCHEDULES (NOT USED)

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. Section includes:
   1. Identification of electrical equipment, devices and components.

1.2  REFERENCES

A. As specified in the Common Work Results for Electrical section.
B. Occupational Safety and Health Administration (OSHA).

1.3  DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

1.4  SYSTEM DESCRIPTION

A. Nameplates:
   1. Provide a nameplate for each piece of electrical equipment and devices, control panel and control panel components.
   2. Provide all nameplates of identical style, color, and material throughout the facility.
   3. Device nameplates information:
      a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.

B. Wire numbers:
   1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
      b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
      c. Internal panel wires on a common terminal shall have the same wire number.
      d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
         1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers in the Conduits section.
   2. Provide the following wiring numbering schemes throughout the project for field wires between process control module, (PCM), vendor control panels, (VCP), motor control centers, (MCC), field starters, field instruments, etc.
(ORIGIN LOC.)—(ORIGIN TERM.)/(DEST. LOC.)—(DEST. TERM.)

OR

a. Where:
   1) ORIGIN LOC. = Designation for originating panel or device
   2) ORIGIN TERM. = Terminal designation at originating panel or device
   3) DEST. LOC. = Designation for destination panel or device
   4) DEST. TERM. = Terminal designation at destination panel or device or PLC
   5) I/O address at destination panel:
      a) Identify equipment and field instruments as the origin.
      b) PCMs are always identified as the destination.
      c) Location is the panel designation for VCP, LCP, or PCM. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
      d) Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
      e) Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
      f) Terminal designations at PCMs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen-Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project).

(1) Discrete Point: W.X.Y.Z.

3. Analog Point: W.X.Y.Z.
   a. Where:
      1) W = I for input, O for output
      2) X = PLC number (1, 2, 3...)
      3) Y = Slot number (01, 02, 03...)
      4) Z = Terminal number (00, 01, 02...) for a discrete point or a word number for an analog point (1, 2, 3...)
   b. Terminal designations at PCMs where the conductor does not connect to a PLC I/O point shall be the terminal number with a 'C' prefix (e.g. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with 'A' (e.g. C0010A).
4. Case 1: Vendor control panel (VCP) to process control module (PCM):
   a. Field wire number/label: A-B/C-D
   b. A = Vendor control panel number without hyphen (VCP#)
   c. B = Terminal number within VCP (manufacturer's or vendor's standard terminal number)
   d. C = Process control module number without hyphen (PCM#)
   e. D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
   f. Examples:
      1) VCP#-10/PCM#-I: 1:01/01
      2) VCP#-10/PCM#-O: 1:10/07
      3) VCP#-10/PCM#-C0100

5. Case 2: Field instrument to process control module (PCM):
   a. Field wire number/label: E-F/C-D
   b. C = Process control module number without hyphen (PCM#)
   c. D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
   d. E = Field mounted instrument tag and loop numbers without hyphen (EDV#)
   e. F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma
   f. Examples:
      1) TIT#-2,3/PCM#-I: 1:01.1
      2) TSH#-1/PCM#-I: 2:01/00

6. Case 3: Motor control center (MCC) to process control module (PCM):
   a. Field wire number/label: G/B/C-D
   b. B = Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number)
   c. C = Process control module number without hyphen (PCM#)
   d. D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
   e. G = Actual starter designation in the motor control center without hyphen (MMS#)
   f. Examples:
      1) MMS#-10/PCM#-I: 1:01/01
      2) MMS#-10/PCM#-O: 1:10/07
      3) MMS#-10/PCM#-C0100

7. Case 4: Motor control center (MCC) to vendor control panel (VCP):
   a. Field wire number/label: G-B/A-B
   b. A = Vendor control panel number without hyphen (VCP#)
   c. B = Terminal number within motor control center or vendor control panel (manufacturer's or vendor's standard terminal number)
   d. G = Actual starter designation in the motor control center without hyphen (MMS#)
   e. Example: MMS#-X2/VCP#-10

8. Case 5: Motor leads to a motor control center (MCC):
   a. Field wire number/label: H-I/G-B
   b. B = Terminal number within motor control center (manufacturer's standard terminal number)
   c. G = Actual starter designation in the motor control center without hyphen (MMS#)
   d. H = Equipment tag and loop number without hyphen (PMP#)
   e. I = Motor manufacturer's standard motor lead identification (e.g. T1, T2, T3, etc.)
   f. Example: PMP#-T3/MMS#-T3
9. Identify all spare conductors as required for other field wires with an “S” prefix:
   a. Example: S MMS#-10/PCM#-C011

1.5 SUBMITTALS

A. Furnish submittals as specified in the Submittal Procedures section and the Common Work Results for Electrical section.

B. Product data:
   1. Nameplates:
      a. Color.
      b. Size:
         1) Outside dimensions.
         2) Lettering.
      c. Material.
      d. Mounting means.
   2. Nameplate schedule:
      a. Show exact wording for each nameplate.
      b. Include nameplate and letter sizes.
   3. Wire numbers:
      a. Manufacturer’s catalog data for wire labels and label printer.

C. Record documents:
   1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.6 QUALITY ASSURANCE (NOT USED)

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT SITE CONDITIONS (NOT USED)

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Nameplates and signs:
   1. One of the following or equal:
      a. Brady.
      b. Seton.

B. Conductor and cable markers:
   1. Heat-shrinkable tubing:
      a. One of the following or equal:
         1) Raychem.
         2) Brady.
         3) Thomas & Betts.
         4) Kroy.
   2. Non heat-shrinkable tubing:
      a. One of the following or equal:
         1) Brady.
         2) Seton.
   3. Pre-printed slip-on sleeve markers:
      a. The following or equal. Engineer knows of no equal.
         1) Grafoplasst.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS

A. Nameplates:
   1. Colors:
      a. Warning nameplates: White-center, red face.
      b. Other nameplates: Black-center, white face.
   2. Laminated plastic engraving stock:
      a. 3/32-inch thick material.
      b. 2-ply.
      c. With chamfered edges.
   3. Block style engraved characters of adequate size to be read easily from a distance of
      6 feet:
      a. No characters smaller than 1/8-inch in height.

B. Signs:
   1. Automatic equipment and high voltage signs:
      a. Suitable for exterior use.
      b. In accordance with OSHA regulations.

C. Conductor and cable markers:
   1. Machine printed black characters on white tubing.
   2. 10-point type or larger.

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS (NOT USED)
2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

   A. Nameplates:
      1. Provide all nameplates for control panel operator devices (e.g. pushbuttons, selector
         switches, pilot lights, etc.):
         a. Same material and same color and appearance as the device nameplates, in
            order to achieve an aesthetically consistent and coordinated system.

PART 3 - EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

   A. As specified in the Common Work Results for Electrical section.

   B. Nameplates:
      1. Attach nameplates to equipment with rivets, bolts or sheet metal screws, approved
         waterproof epoxy-based cement or install in metal holders welded to the equipment.
      2. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy-based
         cement to attach nameplates.
      3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire
         length:
         a. Misaligned or crooked nameplates shall be remounted, or provide new
            enclosures at the discretion of the Engineer.

   C. Conductor and cable markers:
      1. Apply all conductor and cable markers before termination.
      2. Non heat-shrinkable tubing:
         a. Tubing shall be sized for the wire and insulation on which it is to be placed.
         b. Tubing shall be tight on the wire.
         c. Characters shall face the open panel and shall read from left to right or top to
            bottom.
         d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

   D. Signs and labeling:
      1. Furnish and install permanent warning signs at mechanical equipment that may be
         started automatically or from remote locations:
         a. Fasten warning signs with round head stainless steel screws or bolts.
         b. Locate and mount in a manner to be clearly legible to operations personnel.
      2. Furnish and install permanent and conspicuous warning signs on equipment (front and
         back), doorways to equipment rooms, pull boxes, manholes, etc. where the voltage
         exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power.
   a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.

4. Place warning signs on equipment that has 120 VAC control voltage sources used for interlocking.
   a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING (NOT USED)

3.8 FIELD QUALITY CONTROL
   A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_12_30
600-VOLT OR LESS WIRES AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. 600 volt class or less wire and cable.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. ASTM International (ASTM):

C. CSA International (CSA).

D. Insulated Cable Engineers Association (ICEA):
   2. NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.

E. National Fire Protection Association (NFPA):
   1. 72 - National Fire Alarm and Signaling Code.

F. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
   1. 568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
   2. 569-B – Commercial Building Standards for Telecommunications Pathways and Spaces.

G. Underwriter’s Laboratories Inc., (UL):
   1. 44 - Thermoset-Insulated Wires and Cables.
   2. 1277 - Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   4. 1569 - Standard for Metal-Clad Cables.
   5. 2196 - Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.
   6. 2225 - Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.
B. Specific definitions and abbreviations:
   1. AWG: American wire gauge.
   2. BCCS: Bare copper-covered steel.
   3. CPE: Chlorinated polyethylene.
   4. FEP: Fluorinated ethylene propylene.
   5. FHDPE: Foam high-density polyethylene.
   6. FPE: Foam polyethylene.
   7. OD: Outside diameter.
   8. PVC: Polyvinyl chloride.
   9. XHHW: Cross-linked high heat water resistant insulated wire.

C. Definitions of terms and other electrical considerations as set forth in the:
   1. ASTM.
   2. ICEA.

1.4 SYSTEM DESCRIPTION

A. Furnish and install the complete wire and cable system.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
   1. Manufacturer of wire and cable.
   2. Insulation:
      a. Type.
      b. Voltage class.
   3. AWG size.
   4. Conductor material.
   5. Pulling compounds.

C. Shop drawings:
   1. Show splice locations.
      a. For each proposed splice location provide written justification describing why the
         splice is necessary.

D. Test reports:
   1. Submit test reports for meg-ohm tests.

E. Calculations:
   1. Submit cable pulling calculations to the Engineer for review and comment for all cables
      that will be installed using mechanical pulling equipment. Show that the maximum
      cable tension and sidewall pressure will not exceed manufacturer recommended
      values:
      a. Provide a table showing the manufacturer’s recommended maximum cable
         tension and sidewall pressure for each cable type and size included in the
         calculations.
      b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit
         installation.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.
B. All wires and cables shall be UL listed and labeled.

1.7 DELIVERY, STORAGE, AND HANDLING
A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS (NOT USED)

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP
A. As specified in the Common Work Results for Electrical section.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. One of the following or equal:
   1. 600 volt class wire and cable:
      a. General Cable.
      b. Okonite Co.
      c. Southwire Co.
      d. Service Wire.
   2. Instrumentation class wire and cable:
      a. Alpha Wire Co.
      b. Belden CDT.
      c. General Cable.
      d. Okonite Co.
      e. Rockbestos Surprenant Cable Corp.
   3. Network cables:
      a. General Cable.
      b. Belden.
      c. CommScope.
   4. Fire alarm wire and cable:
      a. West Penn Wire.
      b. Olympic Wire and Cable.
      c. Rockbestos Surprenant Cable Corp.
      d. Draka, Lifeline.
2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS

A. Conductors:
   1. Copper in accordance with ASTM B3.

2.4 MANUFACTURED UNITS

A. General:
   1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
   2. Permanently mark each wire and cable with the following at 24-inch intervals:
      a. AWG size.
      b. Voltage rating.
      c. Insulation type.
      d. UL symbol.
      e. Month and year of manufacture.
      f. Manufacturer’s name.
   3. Identify and mark wire and cable as specified in the Identification for Electrical Systems section:
      a. Use integral color insulation for #2 AWG and smaller wire.
      b. Wrap colored tape around cable larger than #2 AWG.

B. 600 volt class wire and cable:
   1. Provide AWG or kcmil sizes as indicated on the Drawings:
      a. When not indicated on the Drawings, size wire as follows:
         1) In accordance with the NEC:
            a) Use 75 degree Celsius ampacity ratings.
            b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
         2) Provide #12 AWG minimum for power conductors.
         3) Provide #14 AWG minimum for control conductors.
   2. Provide Class B stranded in accordance with ASTM B8:
      a. Provide Class C stranded where extra flexibility is required.

3. Insulation:
   a. XHHW-2.
   b. 90 degree Celsius rating.

4. Multiconductor cables:
   a. Number and size of conductors as indicated on the Drawings.
   b. Individual conductors with XHHW-2 insulation.
   c. Overall PVC jacket.
   d. Tray cable rated.
   e. Color-coding for control wire in accordance with ICEA Method 1, E-2 in accordance with NEMA WC 57/ICEA S-73-532.
   f. Ground conductor: Insulated, green:
      1) Sized in accordance with NEC.

C. Instrumentation class cable:
   1. Type TC.
   2. Suitable for use in wet locations.
4. Temperature rating:
   a. 90 degree Celsius rating in dry locations.
   b. 75 degree Celsius rating in wet locations.
5. Conductors:
   a. Insulation:
      1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
   b. #16 AWG stranded and tinned.
   c. Color code: ICEA Method 1:
      1) Pair: Black and white.
      2) Triad: Black, white and red.
      3) Multiple pairs or triads:
         a) Color-coded and numbered.
6. Drain wire:
   a. #18 AWG.
   b. Stranded, tinned.
7. Jacket:
   a. Flame retardant, moisture and sunlight resistant PVC.
   b. Ripcord laid longitudinally under jacket to facilitate removal.
8. Shielding:
   a. Individual pair/triad:
      1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
   b. Multiple pair or triad shielding:
      1) Group shield: Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
      2) Completely isolate group shields from each other.
      3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
   c. All shielding to be in contact with the drain wire.

D. Network cables:
1. Category 6:
   a. General:
      1) Provide Cat 6 cables meeting the standards set by TIA/EIA-568-C.2 and verified by third-party testing laboratory.
   b. Conductors:
      1) #23 AWG solid bare annealed copper.
      2) 4 Bonded pairs.
   c. Drain wire:
      1) #24 AWG stranded (7/32) tinned copper.
   d. Insulation:
      1) Non-Plenum: Polyolefin.
      2) Plenum: Fluoropolymer.
   e. Shielding:
      1) None.
   f. Color code:
      1) Pair 1: White/blue stripe and blue.
      2) Pair 2: White/orange stripe and orange.
      3) Pair 3: White/green stripe and green.
      4) Pair 4: White/brown stripe and brown.
g. Outer jacket:
   1) Non-Plenum: Flame-Retardant PVC.
   2) Plenum: Low-Smoke, Flame-Retardant PVC.

h. Electrical characteristics
   1) Voltage rating: 600VAC.

E. Fire alarm cable:
   1. Number of pairs: As indicated on the Drawings or as necessary for the application.
   2. Voltage rating: 300 V minimum.
   3. 2-hour fire rating in accordance with UL 2196.
   4. Provide fire alarm cable in accordance with the requirements of UL 1424.
   5. Provide Type FPLP (power-limited plenum rated) for all cabling within ducts, plenums,
      and all spaces used for air handling:
      a. Cable must meet NEC standards, and must have adequate fire-resistant and low
         smoke-producing characteristics.
   6. Provide Type FPLR (power-limited riser rated) for all vertical runs that pass from floor
to floor:
      a. FPLR cable must meet NEC standards, and must have fire-resistant
         characteristics capable of preventing the carrying of fire from floor to floor.
   7. FPL (power-limited general purpose) is only suitable for general-purpose fire alarm
      use and shall not be used for risers, ducts, plenums, and in air-handling spaces:
      a. FPL cable must meet NEC standards, and must be listed as resistant to the
         spread of fire.
   8. Cable substitutions are not permitted unless approved by Engineer.
   10. Conductor insulation:
      a. Low smoke PVC.
      b. Minimum 105 degree Celsius rating.
   11. Conductor jacket:
      a. Low smoke PVC.
      b. Ripcord and surface-printed with year of manufacture and cable description at
         maximum 24-inch intervals.
      c. Minimum 105 degree Celsius rating.

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES

A. Wire ties:
   1. One of the following or equal:
      b. Panduit, cable ties.

B. Wire markers:
   1. As specified in the Identification for Electrical Systems section.

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)
2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.

B. Test Type XHHW-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Color-coding:
   1. Color-coding shall be consistent throughout the facility.
   2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Single phase system: Black for 1 hot leg, red for the other.
      e. Neutral: White.
      f. High phase or wild leg: Orange.
      g. Equipment ground: Green.
   3. The following color code shall be followed for all 480/277 volt systems:
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray.
      e. Equipment ground: Green.
   4. The following color code shall be followed for all 120 VAC control wiring:
      a. Power: Red.
   5. The following color code shall be followed for all general purpose DC control circuits:
      a. Grounded conductors: White with blue stripe.
      b. Ungrounded conductors: Blue.
   6. Switch legs shall be violet. 3-way switch runners shall be pink.
   7. Wires in intrinsically safe circuits shall be light blue.
   8. Wire colors shall be implemented in the following methods:
      a. Wires manufactured of the desired color.
      b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
         1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.
C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
   1. Install wires only in approved raceways.
   2. Do not install wire:
      a. In incomplete conduit runs.
      b. Until after the concrete work and plastering is completed.

D. Properly coat wires and cables with pulling compound before pulling into conduits:
   1. For all #4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
      a. Ideal Products.
      b. Polywater Products.
      c. 3M Products.
      d. Greenlee Products.
      e. Or equal as recommended by cable manufacturer.
      f. Do not use oil, grease, or similar substances.

E. Cable pulling:
   1. Prevent mechanical damage to conductors during installation.
   2. For cables #1 AWG and smaller, install cables by hand.
   3. For cables larger than #1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
   4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
   5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.
   6. Make splices or add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer's recommendation for the specified cable size:
      a. Make splices in manholes or pull boxes only.
      b. Leave sufficient slack to make proper connections.

F. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.

G. Install and terminate all wire in accordance with manufacturer's recommendations.

H. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
   1. Do not lace wires in gutter or panel channel.
   2. Install all wire ties with a flush cutting wire tie installation tool:
      a. Use a tool with an adjustable tension setting.
   3. Do not leave sharp edges on wire ties.

I. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
   1. Use ring type lugs if box lugs are not available on the equipment.

J. Lighting circuits:
   1. Each circuit shall have a dedicated neutral.
K. Splices:
1. Provide continuous circuits from origin to termination whenever possible:
   a. Obtain Engineer's approval prior to making any splices.
2. Lighting and receptacle circuit conductors may be spliced without prior approval from
   the Engineer.
3. Where splices are necessary because of extremely long wire or cable lengths that
   exceed standard manufactured lengths:
   a. Splice box NEMA rating requirements as specified in the Common Work Results
      for Electrical section.
   b. Make splices in labeled junction boxes for power conductors.
   c. Make splices for control and instrument conductors in terminal boxes:
      1) Provide terminal boards with setscrew pressure connectors, with spade or
         ring lug connectors.
4. Power and control conductors routed in common raceways may be spliced in common
   junction boxes.
5. Clearly label junction and terminal boxes containing splices with the word "SPLICE
   LOCATED WITHIN".
6. Leave sufficient slack at junction boxes and termination boxes to make proper splices
   and connections. Do not pull splices into conduits.
7. Install splices with compression type butt splices and insulate using a heat-shrink
   sleeve:
   a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are
      listed for submersible applications.
8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas
   shall be made waterproof using:
   a. A heat shrink insulating system listed for submersible applications.
   b. Or an epoxy resin splicing kit.

L. Apply wire markers to all wires at each end after being installed in the conduit and before
   meg-ohm testing and termination.

M. Instrumentation class cable:
1. Install instrumentation class cables in separate raceway systems from power cables:
   a. Install instrument cable in metallic conduit within non-dedicated manholes or pull
      boxes.
   b. Install cable without splices between instruments or between field devices and
      instrument enclosures or panels.
2. Do not make intermediate terminations, except in designated terminal boxes as
   indicated on the Drawings.
3. Shield grounding requirements as specified in the Grounding and Bonding section.

N. Copper Ethernet cables:
2. Pathways:
   a. For initial installation, the maximum fill capacity for pathways (i.e. conduit,
      raceways, trays, baskets) is 40 percent. The maximum fill capacity of 60 percent
      is allowed to accommodate future additions after initial installation.
   b. Conduit should be run in the most direct route possible with no more than two 90
      degree bends between pull boxes and serve no more than 3 outlet boxes.
3. Cable bend radius:
   a. Proper cable bend radius control must be maintained throughout the pathways.
      The bend radius needs to be at a minimum 10 times the cable diameter.
4. Cable pulling:
   a. Provide cable pulling swivel system to prevent winding and tangling of rope and cables during pull.
   b. The maximum pulling tension is not to exceed manufacturer recommendations. Cable installation should not in any way deform the cable jacket.
   c. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

5. Cable management:
   a. Organize and manage cables for quick and easy moves, adds and changes.

6. Testing:
   a. All cables and termination hardware shall be 100 percent tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of TIA/EIA-568-C.1 Section 11.
      1) All pairs of each installed cable shall be verified prior to system acceptance.
      2) Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed.
   b. All twisted-pair copper cable links shall be tested for compliance to the requirements in TIA/EIA/568-C.2 for the appropriate Category of cabling installed.
   c. All cables shall be tested in accordance with the contract documents, TIA/EIA standards, and best industry practice.
   d. The field test equipment shall meet the requirements of TIA/EIA-568-C. The appropriate level III tester shall be used to verify Category 6 cabling.
   e. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
   f. Visually inspect cable placement, cable termination, grounding and bonding, equipment and labeling of all components.
   g. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors.
      1) Test operation of shorting bars in connection blocks.
      2) Test cables after termination but not cross-connection.
         a) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2.
            (1) Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex.
            (2) Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

7. Separation from EMI sources:
   a. Comply with TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
   2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

O. Multi-conductor cable:
   1. Where cable is not routed in conduit with a separate ground conductor, use 1 conductor in the cable as a ground conductor:
      a) Use an internal ground conductor, if it is no smaller than as indicated on the Drawings and in accordance with NEC requirements for equipment ground conductor size.
      b) Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with one of the full-sized conductors serving as ground.

P. Armored cable:
   1. Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with 1 of the full-sized conductors serving as ground.
   2. The cable armor is not acceptable as a ground conductor.
   3. Where armored cable terminates at a device, switchboard, panel, etc., use armored cable connector.
   4. Where armored cable run continues in conduit, strip jacket and armor for portions in conduit, and terminate cable and jacket with an armored cable connector threaded into a coupling or conduit box.

Q. Telephone cable:
   1. Install telephone cables in dedicated metallic raceways, including raceways in duct banks, manholes, and pull boxes.

R. Fire alarm cable:
   1. Install fire alarm cable in dedicated metallic raceways as indicated on the Drawings.

S. Signal cable:
   1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

T. Submersible cable in wet wells:
   1. Provide Kelvin’s grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

U. Wiring allowances:
   1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets,
fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.

2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING

3.8 FIELD QUALITY CONTROL

   A. As specified in the Common Work Results for Electrical section.

   B. Grounding:
      1. As specified in the Grounding and Bonding section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

   A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_13_00

CONDUITS

PART 1  GENERAL

1.1 SUMMARY

A. Section includes:
   1. Metallic conduits.
   2. Nonmetallic conduits.
   3. Conduit bodies.
   4. Conduit fittings and accessories.
   5. Conduit installation.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. American National Standards Institute (ANSI):
   1. C80.1 - Electrical Rigid Steel Conduit.
   2. C80.3 - Steel Electrical Metallic Tubing.
   3. C80.5 - Electrical Rigid Aluminum Conduit.
   4. C80.6 - Electrical Intermediate Metal Conduit.

C. National Electrical Manufacturer’s Association (NEMA):
   1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
   2. TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
   3. TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   4. TC7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
   5. TC13 - Electrical Nonmetallic Tubing.
   6. TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

D. Underwriters Laboratories (UL):
   1. 1 - Standard for Flexible Metal Conduit.
   2. 6 - Standard for Electrical Rigid Metal Conduit - Steel.
   3. 6A - Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel.
   4. 360 - Standard for Liquidtight Flexible Steel Conduit.
   5. 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
   6. 651B - Standard for Continuous Length HDPE Conduit.
   7. 797 - Standard for Electrical Metallic Tubing - Steel.
   8. 1242 - Standard for Electrical Intermediate Metal Conduit - Steel.
   10. 1660 - Standard for Liquidtight Flexible Nonmetallic Conduit.
   11. 1684 - Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.
B. Specific definitions and abbreviations:
1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, Shapes C, E, LB, T, X, etc.
2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.
3. GRC: Galvanized rigid steel conduit.
4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
5. EMT: Electrical metallic tubing.
6. PVC: Polyvinyl chloride rigid nonmetallic conduit.
7. SLT: Sealight-liquidtight flexible conduit.
8. EFLX: Explosion proof flexible conduit.
9. RAC: Rigid aluminum conduit.
10. NPT: National pipe thread.

1.4 SUBMITTALS
A. Furnish submittals as specified in the Common Work Results for Electrical section.
B. Product data:
   1. Furnish complete manufacturer’s catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
   2. Furnish complete manufacturer’s recommended special tools to be used for installation if required.
C. Certifications:
   1. Furnish PVC-coated conduit manufacturer’s certification for each installer.
D. Record Documents:
   1. Incorporate all changes in conduit routing on electrical plan drawings,
   2. Dimension underground and concealed conduits from building lines,
   3. Furnish hard copy drawings.

1.5 QUALITY ASSURANCE
A. As specified in the Common Work Results for Electrical section.
B. All conduits, conduit bodies, and fittings shall be UL listed and labeled.
C. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit.

1.6 DELIVERY, STORAGE, AND HANDLING
A. As specified in the Common Work Results for Electrical section.
B. Do not expose non-metallic conduit to direct sunlight.
C. Do not store conduit in direct contact with the ground.
D. Do not store aluminum conduit in contact with concrete.
1.7 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.8 SEQUENCING

A. Before installing any conduit or locating any device box:
   1. Examine the complete set of Drawings and Specifications, and all applicable shop drawings.
   2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

1.9 SCHEDULING (NOT USED)

1.10 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.11 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Galvanized rigid steel conduit:
   1. One of the following or equal:
      a. Western Tube and Conduit.
      b. Allied Tube and Conduit.
      c. Wheatland Tube Co.

B. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Robroy Ind.
      b. Ocal, Inc.
      c. Calbond.
      d. Allied.
      e. NEC, Inc. BlackGuard.

C. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. Southwire.
      b. AFC Cable Systems.
      c. Electri-Flex Co.
      d. Anaconda.

D. Explosion proof flexible conduit:
   1. One of the following or equal:
      a. Appleton.
b. Crouse-Hinds.
c. Hubbell Killark.

E. Conduit bodies:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.
      d. Ocal, Inc.
      e. Robroy Ind.
      f. Calbond.
      g. Carlon.

F. Joint compound:
   1. The following or equal:
      a. Thomas and Betts.

G. Galvanized rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.

H. PVC-coated rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. Ocal, Inc.
      b. Robroy Ind.
      c. NEC, Inc. BlackGuard.

I. Conduit sleeve:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.

J. Conduit seals:
   1. One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.
      c. O-Z/Gedney.

K. Conduit hangers and supports:
   1. As specified in the Hangers and Supports section.

L. Conduit through wall and floor seals:
   1. The following or equal:
      a. O-Z/Gedney:
         1) Type “WSK.”
         2) Type “CSM.”

2.2 SYSTEM DESCRIPTION

A. Provide conduits, conduit bodies, fittings, junction boxes, and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.
2.3 EXISTING PRODUCTS (NOT USED)

2.4 MATERIALS (NOT USED)

2.5 MANUFACTURED UNITS (NOT USED)

2.6 EQUIPMENT (NOT USED)

2.7 COMPONENTS

A. GRC:
   1. All threads: NPT standard conduit threads with a 3/4-inch taper per foot:
      a. Running conduit threads are not acceptable.
   2. Hot-dip galvanized inside and out:
      a. Ensures complete coverage and heats the zinc and steel to a temperature that
         ensures the zinc alloys with the steel over the entire surface.
      b. Electro-galvanizing is not acceptable.
   3. Manufactured in accordance with:
      a. UL-6.
      b. ANSI C80.1.

B. PCS:
   1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized
      material, conforming to the requirements for Type GRC.
   2. Coated conduit NEMA Standard RN-1:
      a. The galvanized coating may not be disturbed or reduced in thickness during the
         cleaning and preparatory process.
   3. Factory-bonded PVC jacket:
      a. The exterior galvanized surfaces shall be coated with primer before PVC coating
         to ensure a bond between the zinc substrate and the PVC coating.
      b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where
         part configuration or application of the piece dictates otherwise.
      c. PVC coating on conduits and associated fittings shall have no sags, blisters,
         lumps, or other surface defects and shall be free of holes and holidays.
      d. The PVC adhesive bond on conduits and fittings shall be greater than the tensile
         strength of the PVC plastic coating:
   4. 1) Confirm bond with certified test results.
   4. A urethane coating shall be uniformly and consistently applied to the interior of all
      conduits and fittings:
      a. Nominal thickness of 0.002 inch.
      b. Conduits having areas with thin or no coating are not acceptable.
      c. All threads shall be coated with urethane.
   5. The PVC exterior and urethane interior coatings applied to the conduits shall afford
      sufficient flexibility to permit field bending without cracking or flaking at temperature
      above 30 degrees Fahrenheit (-1 degree Celsius).
   6. PCS conduit bodies and fittings:
      a. Malleable iron.
      b. The conduit body, before PVC coating, shall be new, unused material and shall
         conform to appropriate UL standards.
      c. The PVC coating on the outside of conduit bodies shall be 0.040-inch thick and
         have a series of ribs to protect the coating from tool damage during installation.
      d. 0.002-inch interior urethane coating.
      e. Utilize the PVC coating as an integral part of the gasket design.
      f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure
         corrosion protection.
g. A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
1) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
2) The sleeve shall provide a vapor- and moisture resistant seal at every connection.

C. SLT:
1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
   a. General purpose:
      1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
   b. Oil-resistant:
      1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
2. Sunlight-resistant, weatherproof, and watertight.
3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
5. Overall PVC jacket.
6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.

D. EFLX:
1. Suitable for the hazardous Class and Group where installed:
   a. As specified in the Common Work Results for Electrical section.
2. Metallic braid shall provide continuous electrical path.
4. Provide fittings and unions as required for the installation.

E. PVC:
1. Extruded from virgin PVC compound:
   a. Schedule 40 unless otherwise specified.
   b. Schedule 80 extra-heavy wall where specified.
2. Rated for 90 degrees Celsius conductors or cable.
3. Rated for use in direct sunlight.

F. Conduit bodies:
1. Material consistent with conduit type:
   a. Malleable iron bodies and covers when used with Type GRC.
   b. Cast aluminum bodies and covers when used with Type RAC.
   c. PVC bodies and covers when used with Type PVC.
   d. PVC-coated malleable iron bodies and covers when used with Type PCS.
2. Conduit bodies to conform to Form 8, Mark 9, or Mogul design:
   a. Mogul design conforming to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

2.8 ACCESSORIES

A. Connectors and fittings:
1. Manufactured with compatible materials to the corresponding conduit.
B. Insulated throat metallic bushings:
   1. Construction:
      a. Malleable iron or zinc-plated steel when used with steel conduit.
      b. Aluminum when used with aluminum conduit.
      c. Positive metallic conduit end stop.
      d. Integrally molded non-combustible phenolic-insulated surfaces rated at
         150 degrees Celsius.
      e. Use fully insulated bushings on nonmetallic conduit system made of high-impact
         150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated grounding bushings:
   1. Construction:
      a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
      b. Integrally molded non-combustible phenolic-insulated surfaces rated at
         150 degrees Celsius.
      c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.

D. Electrical unions (Erickson Couplings):
   1. Construction:
      a. Malleable iron for use with steel conduit.
      b. Aluminum for use with aluminum conduit.
      c. Concrete tight, 3-piece construction.
      d. Rated for Class I Division 1 Group D in hazardous areas.

E. SLT fittings:
   1. Construction:
      a. Malleable iron.
      b. Furnished with locknut and sealing ring.
      c. Liquidtight, raintight, oiltight.
      d. Insulated throat.
      e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
      f. Designed to prevent sleeving:
         1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
         2) Equipped with grounding device to provide ground continuity irrespective of
            raceway core construction. Grounding device, if inserted into raceway and
            directly in contact with conductors, shall have rolled-over edges for sizes under 5
            inches.
         h. Where terminated into a threadless opening using a threaded hub fitting, a
            suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided
            between the outside of the box or enclosure and the fitting shoulder. Gasket shall
            be adequately protected by and permanently bonded to a metallic retainer.
   2. Corrosion-resistant and outdoor SLT fittings:
      a. Construction:
         1) PVC-coated liquidtight fittings with a bonded 0.040-inch thick PVC coating
            on the metal connector to form a seal around the SLT conduit.
         2) Insulated throat and an integral sealing ring.

F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
   1. Construction:
      a. Insulated throat.
      b. PVC-coated when used in corrosive areas.
      c. Bonding locknut.
      d. Recessed neoprene o-ring to ensure watertight and dusttight connector.
      e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
      f. 1-1/2-inch through 6-inch malleable iron zinc plated.
      g. Aluminum with aluminum conduit.
2. Usage:
   a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

G. Sealing fittings:
   1. Construction:
      a. 40-percent wire fill capacity.
      b. PVC-coated when used in corrosive areas.
      c. Malleable ductile iron with steel conduit.
      d. Aluminum with aluminum conduit.
      e. Type EYDX where drains are required.
      f. Type EYSX where drains are not required.
      g. UL listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.

   2. Sealing compound:
      a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
      b. Approved for the conditions and use.
         1) Not affected by surrounding atmosphere or liquids.
      c. Melting point shall be 200 degrees Fahrenheit minimum.

H. PVC fittings:
   1. Materials:
      a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.
      b. All metal hardware shall be stainless steel.

I. Through wall and floor seals:
   1. Materials:
      a. Body: Casting of malleable or ductile iron with a hot-dip galvanized finish
         Aluminum.
      b. Grommet: Neoprene.
      c. Pressure rings: PVC-coated steel.
      d. Disc material: PVC-coated steel.

J. Expansion/deflection couplings:
   1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
   2. Shall allow movement of 3/4 inch from the normal in all directions.
   3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
   4. Constructed to maintain electrical continuity of the conduit system.
   5. Materials:
      a. End couplings: Bronze or galvanized ductile iron.
      b. Sleeve: Neoprene.
      d. Bonding jumper: Tinned copper braid.

K. Expansion couplings:
   1. Shall allow for expansion and contraction of conduit:
      a. Permitting 8-inch movement, 4 inches in either direction.
   2. Constructed to maintain electrical continuity of the conduit system.
   3. Materials:
      a. Head: Malleable or ductile iron.
      b. Sleeve: Steel.
      c. Insulating bushing: Phenolic.
      d. Finish: Hot-dip galvanized.
e. Aluminum when used with Type RAC.
f. PVC-coated when used with Type PCS.

L. Conduit markers:
   1. As specified in the Identification for Electrical Systems section.

2.9 MIXES (NOT USED)
2.10 FABRICATION (NOT USED)
2.11 FINISHES (NOT USED)
2.12 SOURCE QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)
3.2 PREPARATION (NOT USED)
3.3 INSTALLATION
   A. As specified in the Common Work Results for Electrical section.
   B. General:
      1. Conduit routing:
         a. The electrical drawings are diagrammatic in nature:
            1) Install conduit runs as specified with schematic representation indicated on
               the Drawings and as specified.
            2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
               a) Make changes in conduit locations that are consistent with the design
                  intent but are dimensionally different, or routing to bypass obstructions.
               b) Make changes in conduit routing due to the relocation of equipment.
            3) The electrical drawings do not indicate all required junction boxes and pull
               boxes:
               a) Provide junction boxes and pull boxes to facilitate wire pulling as
                  required:
                  (1) To meet cable manufacturer’s pulling tension requirements.
                  (2) To limit total conduit bends between pull locations.
               b) Install junction boxes and pull boxes at locations acceptable to the
                  Engineer.
         b. The Contractor is responsible for any deviations in general location, conduit size,
            routing, or changes to the conduit schedule without the express written approval
            or direction by the Engineer:
            1) The Engineer is the sole source in determining whether the change is
               constituted as a deviation:
            2) Perform any changes resulting in additional conduits, or extra work from
               such deviations.
            3) Incorporate any deviations on the Record Documents.
      2. Use only tools recommended by the conduit manufacturer for assembling the conduit
         system.
3. Provide adequate clearances from high-temperature surfaces for all conduit runs. Provide minimum clearances as follows:
   a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
   b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.
   c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
   d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.

4. Support conduit runs on water-bearing walls a minimum of 7/8-inch away from wall on an accepted preformed channel:
   a. Do not run conduits within water-bearing walls unless otherwise indicated on the Drawings.

5. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.

6. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
   a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
   b. Make changes in direction with long radius bends or with conduit bodies.

7. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.

8. Route all exposed conduits to preserve headroom, access space and work space, and to prevent tripping hazards and clearance problems:
   a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
   b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.

9. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.

10. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.

11. Install conduits through wall and floor seals where indicated on the Drawings.

12. For existing and new 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
    a. Remove and replace conduits through which mandrel will not pass.

13. Provide all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.

14. Install complete conduit systems before conductors are installed.

15. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.

16. Underground conduits:
    a. Install underground conduits, including conduit runs below slabs-on-grade in duct bank construction:
       1) As specified in the Duct Banks section.
    b. Make underground conduit size transitions at handholes and manholes.
    c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.
d. Seal around conduit penetrations of below grade walls with a mechanical seal.

C. Lighting and receptacle conduits:
1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings:
2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
3. Minimum conduit size:
   a. 3/4-inch for exposed conduits.
   b. 1-inch for underground or in-slab conduits.
4. Provide conduit materials for the installed location as specified in the Common Work Results for Electrical section.

D. Conduit usage:
1. Exposed conduits:
   a. Rigid conduit:
      1) Install the rigid conduit type for each location as specified in the Common Work Results for Electrical section.
      2) Minimum size: 3/4-inch.
   b. Flexible conduit:
      1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
         a) Use Type SLT with rigid metallic conduit.
         b) Use Type EFLX in Class I Division 1 locations.
      2) Minimum size: 3/4-inch:
         a) 1/2 when required for connection to instruments.
      3) Maximum length:
         a) Fixed equipment:

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<tr>
<th>Conduit Trade Size</th>
<th>Flexible Conduit Length (inch)</th>
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<tbody>
<tr>
<td>3/4</td>
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<td>38</td>
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   b) Removable instruments or hinged equipment:
      (1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.

2. Concrete-encased and embedded conduits:
   a. Straight runs and bends less than 45 degrees:
      1) Type PVC Schedule 40.
   b. Bends with total deflection greater than 45 degrees:
      1) PCS.
c. Entering and exiting duct bank, underground or embedded conduit runs a minimum 12 inches above and below grade, finished floor, or entering equipment:
   1) PCS.

d. Minimum size:
   1) 2-inch in duct banks.
   2) 1-inch for in-slab conduits.
   3) Provide conduit fittings to enlarge the conduit from the exposed size in the conduit schedule as required.

3. Direct-buried and sand-bedded duct bank conduits:
   a. Type PCS.

4. Below-slab conduits:
   a. Type PCS.

5. PVC-coated rigid metallic conduit:
   a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.

6. GRC:
   a. Conduit shall be cut square and reamed before threading.

E. Conduit joints and bends:
   1. General:
      a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquid tight.
      b. Keep bends and offsets in conduit runs to an absolute minimum.
      c. All bends shall be symmetrical.
      d. The following conduit systems shall use large-radius sweep elbows:
         1) Underground conduits.
         2) Conduits containing fiber optic cables.
      e. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.
      f. Make field bends with a radius of not less than the requirements found in the NEC:
         1) The minimum bending radius of the cable must be less than the radius of the conduit bend.
         2) Make all field bends with power bending equipment or manual benders specifically intended for the purpose:
            a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
            b) For the serving utilities, make bends to meet their requirements.
      g. Replace all deformed, flattened, or kinked conduit.

   2. Threaded conduit:
      a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that all bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
      b. Thoroughly ream conduit after threads have been cut to remove burrs.
      c. Use bushings or conduit fittings at conduit terminations.
      d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar ", or CRC "Zinc It."
      e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
         1) Apply to the male threads and tighten joints securely.
         2) Clean excess sealant from exposed threads after assembly.
f. Securely tighten all threaded connections.
g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating.

3. PVC:
a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at all bends:
   1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.

F. Conduit sealing and drainage:
1. Conduit drainage and sealing other than required for hazardous and classified areas:
a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
   1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.
d. Provide conduit seals similar to O-Z/Gedney (Type CSM) on all conduits between corrosive and non-corrosive areas.
e. Seal one end only of all underground conduits at highest point with O-Z/Gedney sealing (non-hazardous) filling, or equal.
2. Install seals with drains at any location along conduit runs where moisture may condense or accumulate. This requirement includes, but is not limited to, the following locations: control panels, junction boxes, pullboxes, or low points of the conduit.

G. Conduit supports:
1. General:
a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
   1) As specified in the Hangers and Supports section.
   2) Provide support materials consistent with the type of conduit being installed as specified in the Common Work Results for Electrical section.
b. Support conduit at the intervals required by the NEC.
c. Perforated strap and plumbers tape are not acceptable for conduit supports.
2. Conduit on concrete or masonry:
a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
b. Use preset inserts in concrete when possible.
c. Use pipe spacers (clamp backs) in wet locations.
3. Suspended conduit:
a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
b. For grouped conduits, construct racks with threaded rods and tiered angles or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2-feet long, provide rigid sway bracing.
4. Supports at structural steel members:
a. Use beam clamps.
b. Drilling or welding may be used only as specified or with approval of the Engineer.
5. PVC-coated rigid metal systems:
   a. Provide right-angle beam clamps and “U” bolts specially formed and sized to
      snugly fit the outside diameter of the coated conduit. Provide “U” bolts with PVC-
      encapsulated nuts that cover the exposed portions of the threads.
   b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.

H. Expansion or expansion/deflection fittings:
   1. General:
      a. Align expansion coupling with the conduit run to prevent binding.
      b. Follow manufacturer’s instructions to set the piston opening.
      c. Install expansion fittings across concrete expansion joints and at other locations
         where necessary to compensate for thermal or mechanical expansion and
         contraction.
      d. Furnish fittings of the same material as the conduit system.
   2. For metallic conduit, provide expansion or expansion/deflection couplings, as
      appropriate, where:
      a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.

I. Empty conduits:
   1. Provide a polyethylene rope rated at 250 pounds tensile strength in each empty
      conduit more than 10 feet in length.
   2. Seal ends of all conduits with approved, manufactured conduit seals, caps, or plugs
      immediately after installation:
      a. Keep ends sealed until immediately before pulling conductors.

J. Miscellaneous:
   1. Seal roof penetrations for raceways and other items that penetrate the roof in
      accordance with roofing manufacturer’s instructions and as indicated on the Drawings.
   2. Provide electrical unions at all points of union between ends of rigid conduit systems
      that cannot otherwise be coupled:
      a. Running threads and threadless couplings are not allowed.
   3. Replace any conduits installed that the Engineer determines do not meet the
      requirements of this Specification.

3.4 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)
3.7 COMMISSIONING (NOT USED)
3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.
3.9 ADJUSTING (NOT USED)
3.10 CLEANING (NOT USED)
3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTIOI 26_13_30
DUCT BANKS

PART 1  GENERAL

1.01 SUMMARY
A. Section includes:
1. Electrical underground duct banks.
2. Duct bank installation requirements.

1.02 REFERENCES
A. As specified in the Common Work Results for Electrical section.

1.03 DEFINITIONS
A. As specified in the Common Work Results for Electrical section.

1.04 SYSTEM DESCRIPTION
A. Provide trenching, forming, spacers, conduit, backfill, and compaction necessary for the complete installation of the duct banks.
B. Provide duct banks for all conduits installed below grade, on the site, below structures, or in contact with the earth, unless otherwise indicated on the Drawings.

1.05 SUBMITTALS
A. Furnish submittals as specified in the Submittal Procedures section and the Common Work Results for Electrical section.
B. Product data:
   1. PVC conduit spacers.
   2. Detectable underground marking tape.
   3. Pull line.
C. Shop drawings:
   1. Submit site plan drawings of duct banks including underground profiles indicating all underground utilities.
   2. For duct bank routings crossing under building footers or foundations alternative to designed routings indicated on the Drawings:
      a. Submit shop drawings detailing the new building footer crossing locations and plan drawings labeling all equipment to be installed on top of the new routing for approval by the project Structural Engineer.

1.06 QUALITY ASSURANCE
A. As specified in the Common Work Results for Electrical section.

1.07 DELIVERY, STORAGE, AND HANDLING
A. As specified in the Common Work Results for Electrical section.
1.08 PROJECT OR SITE CONDITIONS
   A. As specified in the Common Work Results for Electrical section.

1.09 SEQUENCING

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
   A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP
   A. As specified in the Common Work Results for Electrical section.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Conduit spacers:
      1. One of the following or equal:
         b. Cantex.
         c. Osburn Associates, Inc.

   B. Detectable underground marking tape:
      1. One of the following or equal:
         a. Blackburn Manufacturing Co.
         b. Pro-Line Safety Products.
         c. Panduit.

   C. Pull line:
      1. One of the following or equal:
         a. Arnco.
         b. Greenlee.
         c. Osburn Associates, Inc.

   D. Duct seal:
      1. The following or equal:
         a. OZ Gedney type DUX.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS
   A. Provide conduit as specified in the Conduits section:
      1. Use duct suitable for use with 194 degree Fahrenheit rated conductors.
2.04 MANUFACTURED UNITS

A. Conduit spacers:
   1. Provide conduit spacers recommended by the conduit manufacturer or specified above.
   2. Saddle type.
   3. Non-metallic, non-corrosive, non-conductive.
   4. Interlocking type:
      a. Vertical interlocking.
      b. Horizontal interlocking.
   5. Suitable for concrete encasement.
   7. Accommodates 2-inch through 6-inch conduit sizes.
   8. Relieves the conduit from both horizontal and vertical stresses.

B. Pull line:
   1. Minimum 1/4-inch wide, flat design.
   2. Polyester.
   3. Minimum pulling strength 1,200 pounds.

C. Detectable marking tape:
   1. Provide a detectable tape, locatable by a cable or metal detector from above the undisturbed grade.
   2. Aluminum core laminated between polyethylene film.
   3. 6-inch wide red tape imprinted with black lettering stating "CAUTION - BURIED ELECTRIC LINE BELOW" or equivalent.

D. Duct seal:
   1. Non-hardening sealing compound.
   2. Flexible, can be applied by hand.
   3. UL Listed for use with installed conductors.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)
3.03 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Duct banks:
   1. Install duct banks at least 24 inches below finish grade, unless otherwise indicated on the Drawings.
   2. Damage minimization:
      a. Conduit should not be left exposed in an open trench longer than is necessary.
      b. Protect all underground duct banks against damage during pouring of concrete or backfilling.
   3. All plastic conduit fittings to be joined should be exposed to the same temperature conditions for a reasonable length of time before assembly.
   4. Provide No. 4/0 American Wire Gauge bare copper ground wire the entire length of duct bank and bond to the grounding system at each end of the duct bank.
   5. Install underground ducts to be self-draining:
      a. Slope duct banks away from buildings to manholes, handholes, or pullboxes.
      b. Slope duct banks uniformly from manholes, handholes, or pullboxes to manholes, handholes, or pullboxes or both ways from high points between manholes, handholes, or pullboxes.
      c. Slope a minimum of 1/4 inch per 10 feet.
   6. Where new duct banks join to existing manholes, handholes, or pullboxes, make the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions, as indicated on the Drawings.
   7. Install pull line in spare conduits:
      a. Provide adequate pull line at both ends of conduits to facilitate conductor pulling.
      b. Cap above ground spare conduit risers at each end with screw-on conduit caps.

C. Trenching:
   1. Trench must be uniformly graded with the bottom, rock free and covered with select material.
   2. Whenever possible, use the walls of the trench as forms for concrete encasement:
      a. Forms are required where the soil is not self-supporting.
   3. Avoid damaging existing ducts, conduits, cables, and other utilities.

D. Duct spacing:
   1. Separate conduits with manufactured plastic spacers using a minimum space between the outside surfaces of adjacent conduits of 2 inches, unless otherwise indicated on the Drawings:
      a. Separate medium voltage ducts a minimum of 7.5 inches on center.
   2. Install spacers to maintain uniform spacing of duct assembly a minimum of 4 inches above the bottom of the trench during concrete pour. Install spacers on 8-foot maximum intervals:
      a. Due to some distortion of conduit from heat, and other means, it may be necessary to install extra spacers within the duct bank:
         1) Install the intermediate set of spacers within normal required spacing to maintain the proper horizontal clearance:
            a) Clearance is required to allow the proper amount of concrete to infiltrate vertically among the duct to ensure proper protection.
      3. Spacers shall not be located at the center of a bend:
         a. Locate spacer in the tangent, free of the coupling on fabricated bends.
         b. Locate spacers midway between the tangent and the center bend on trench formed sweeps.
E. Terminating:
1. Use bell ends in duct at entrances into cable vaults.
2. Make conduit entrances into cable vaults tangential to walls of cable vault.
3. Form trapezoidal transitions between duct bank and cable vaults as needed in order to
   ensure adequate cable bending radius for the duct bank-to-vault transition.
4. Install duct seal in all conduits including spare conduits, at entrance to
   manholes/handholes, and building/equipment stub-ups. Form by hand to conduit and
   around cables to develop moisture barrier.
5. New manhole or handhole applications, provide a single opening or “window” per duct
   bank, sized to accommodate the duct bank envelope.

F. Marking tape:
1. Install a detectable marking tape 12 inches above the duct bank the entire length of
   the duct bank.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING (NOT USED)

3.08 FIELD QUALITY CONTROL
   A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING
   A. Clean conduits of dirt and debris by use of an appropriately sized steel mandrel no less than
     1/2 inch smaller than the inside diameter of the conduit.

3.11 PROTECTION
   A. As specified in Section 16050 - Common Work Results for Electrical,
   B. Provide shoring and pumping to protect the excavation and safety of workers.
   C. Protect excavations with barricades as required by applicable safety regulations.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_13_40

BOXES

PART 1  GENERAL

1.1  SUMMARY

A. Section includes:
   1. Device boxes.
   2. Raceway system boxes.

1.2  REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. American Association of State Highway and Transportation Officials (AASHTO):

C. ASTM International (ASTM):

D. Joint Industry Conference (JIC).

E. Underwriters Laboratories, Inc. (UL):
   1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3  DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

B. Specific definitions:
   1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
   2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.4  SYSTEM DESCRIPTION

A. Provide outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction, and pullboxes for use in the raceway systems, etc.
B. Provide boxes as indicated on the Drawings or as needed to complete the raceway installation.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
   1. Manufacturer.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
      d. Weight.
      e. NEMA rating.
   4. Conduit entry locations.
   5. Catalog cut sheets.
   6. Installation instructions.

C. Shop drawings:
   1. Include identification and sizes of pullboxes.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. Regulatory requirements:
   1. Outlet boxes shall comply with all applicable standards of:
      a. JIC.
      b. NEC.
      c. NEMA.
      d. UL.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING

A. As specified in the Common Work Results for Electrical.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.
1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
   1. Cast device boxes:
      a. Appleton.
      b. Crouse-Hinds.
      c. OZ/Gedney.
   2. Stainless steel enclosures:
      a. Hoffman.
      b. Stahlin.
      c. Rittal.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS

A. Cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Tapered threaded hubs with integral bushing.
   2. Malleable iron boxes:
      a. Conforming to ASTM A47 Grade 32510.

B. Plastic coated cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Double coated with a nominal 0.002-inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
      f. With a minimum 0.040-inch (40 mil) PVC coating bonded to exterior.
      g. With pressure sealing sleeve to protect the connection with conduit.

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES

A. Fasteners:
   1. Electroplated or stainless steel in boxes with wiring devices.
   2. Screws, nuts, bolts, and other threaded fasteners:
      a. Stainless steel.
B. Provide breather and drain fittings where appropriate.

C. Internal panels:
   1. Provide internal panels where required for mounting of terminal strips or other equipment.
   2. With plated steel shoulder studs.
   3. Steel with white polyester powder finish.

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. General:
   1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in the Common Work Results for Electrical section.
   2. Provide outlet box materials to match the conduit system:
      a. GRC - Cast ferrous boxes.
      b. PCS - PVC coated cast ferrous boxes.
      c. PVC - PVC boxes.
   3. Solid type gang boxes:
      a. For more than 2 devices.
      b. For barriered outlets.
   4. Support all wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8-inch free air space between the back of the enclosure and the wall:
      a. Use machined spacers to maintain air space; built-up washers are not acceptable.
      b. Use stainless steel or nylon materials for spacers.
   5. Use cast malleable iron boxes when box must support other devices.
   6. Boxes serving luminaires or devices:
      a. Use as pullboxes wherever possible.
   7. Fit all cast boxes and pressed steel boxes for flush mounting in concrete with cast, malleable box covers and gaskets.
   8. In terminal boxes, furnish terminals as indicated on the Drawings, with a minimum of 50 percent spare terminals:
      a. Furnish wireways for discrete and analog/DC wiring.
      b. Separate analog wiring from 120 V discrete or power wiring.
   9. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.
   10. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.
C. Outlet boxes:
   1. Locate outlet boxes as indicated on the Drawings:
      a. Adjust locations so as not to conflict with structural requirements or other trades.
   2. Use deep threaded-hub malleable iron or aluminum boxes:
      a. In hazardous areas.
      b. Where exposed to the weather.
      c. In unheated areas.
      d. Where subject to mechanical damage:
         1) Defined as exposed boxes less than 10 feet above the floor.
      e. To act as a pullbox for conductors in a conduit system.
      f. Accommodate wiring devices.
   3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.
   4. Outlet boxes may be used as junction boxes wherever possible.

D. Pullboxes and junction boxes:
   1. Size pullboxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
   2. Install pullboxes such that access to them is not restricted.

E. For boxes not indicated:
   1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in the Common Work Results for Electrical section.
   2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations:
      a. One-piece, galvanized, pressed steel.
   3. Ceiling boxes for flush mounting in concrete:
      a. Deep, galvanized, pressed steel.
   4. Outlet, switch, and junction boxes where surface mounted in exposed locations:
      a. Cast ferrous boxes with mounting lugs, zinc or cadmium plating finish.
   5. Outlet, control station, and junction boxes for installation in corrosive locations:
      a. Fiberglass reinforced polyester, stainless steel, or plastic coated steel to match the conduit system.
      b. Furnished with mounting lugs.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 REINSTALLATION (NOT USED)
3.7 COMMISSIONING
   A. As specified in the Commissioning section.
3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.
3.9 ADJUSTING (NOT USED)
3.10 CLEANING
   A. As specified in the Common Work Results for Electrical section.
3.11 PROTECTION
   A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_15_00
LOW VOLTAGE WIRE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Wire connecting devices.
   2. Terminations.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. ASTM International (ASTM):

C. CSA International (CSA):
   1. C22.2 - No.197-M1983 (R2208) - PVC Insulating Tape.

D. Underwriters Laboratories, Inc. (UL):
   1. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

1.4 SYSTEM DESCRIPTION

A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
   1. Catalog cut sheets.
   2. Installation instructions.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. All materials shall be UL listed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.
1.8 PROJECT OR SITE CONDITIONS
A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP
A. As specified in the Common Work Results for Electrical section.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers for each type of technology are specified with the equipment in this Section.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT

A. Control connections:
1. Use insulated ring type wire terminators for connections to all screw terminals:
   a. With chamfered/funneled terminal barrel entry.
   b. Deep internal serrations.
   c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
   d. Electroplated-tin copper conductor.
   e. Manufacturers: The following or equal:
      1) Thomas and Betts, Stakon.

2. For process equipment connections work from manufacturer's drawings.

B. Joints, splices, taps, and connections:
1. 600-volt conductors:
   a. Use solderless connectors.
   b. Use only plated copper alloy connectors or lugs:
      1) Aluminum connectors or lugs are not acceptable for copper conductors.
   c. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
d. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps:
   1) Manufacturers: The following or equal:
      a) Buchanan, 2006S or 2011S, with 2007 or 2014 insulating caps.

e. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
   1) Manufacturers: One of the following or equal:
      a) Burndy.
      b) Thomas and Betts.

f. Heat shrink tubing:
   1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
   2) Minimum shrink ratio: 4 to 1.
   3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
   4) Internally applied adhesive sealant.
   5) Cross-linked polyolefin:
      a) Manufacturers: One of the following or equal:
         (1) 3M, ITCSN.
         (2) Thomas & Betts, Shrink-Kon.

2. Instrumentation class cable splices:
   a. Suitable for indoor, outdoors, weather exposed, direct buried, or submerged applications.
   b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
   c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
   d. Two-part mold body with tongue and groove seams and built in spacer webbing.
   e. Manufacturers: The following or equal:
      1) 3M, Scotchcast 72-N.

C. Insulating tape:
1. General purpose insulating tape:
   a. Minimum 7 mil vinyl tape.
   b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
   c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
   d. Flame retardant, hot- and cold- weather resistant, UV resistant.
   e. For use as a primary insulation for wire cable splices up to 600 VAC.
   f. Meeting and complying with:
      1) ASTM D3005 Type I.
      2) UL 510.
      3) CSA C22.2.
   g. Manufacturers: The following or equal:
      1) 3M, Scotch Number Super 33+.

2. General-purpose color-coding tape:
   a. Minimum 7 mil vinyl tape.
   b. Suitable for application on PVC and polyethylene jacketed cables.
   c. For use indoors and outdoors in weather protected enclosures.
   d. Available with the following colors:
      1) Red.
      2) Yellow.
      3) Blue.
      4) Brown.
      5) Gray.
      6) White.
      7) Green.
8) Orange.
9) Violet.
e. For use as phase identification, marking, insulating, and harnessing.
f. Meeting and complying with:
   1) UL 510.
   2) CSA C22.2.
g. Manufacturers: The following or equal:
   1) 3M, Scotch Number 35.

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Load connections:
   1. Connect loads to the circuits as indicated. Color-code all branch circuits as specified in
      Section 16123 - 600-Volt or Less Wires and Cables.

C. Zero to 600-volt systems:
   1. Make all connections with the proper tool and die as specified by the device
      manufacturer.
   2. Use only tooling and dies manufactured by the device manufacturer.
   3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded
      plastic covers, or heat shrink tubing and caps.
   4. Number all power and control wires before termination.

D. Motor connections (600 volts and below):
   1. Terminate all leads and wires with compression type ring lugs.
   2. Terminations on all motor leads, including leads that are connected together to
      accommodate the motor voltage, and the machine wires entering the motor terminal
      box from the power source, shall have ring type compression lugs.
   3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material
      formed as a single opening boot:
      a. In damp and wet locations, use a complete kit containing mastic that shall seal
         out moisture and contamination.
      b. Shrink cap with low heat as recommended by manufacturer.
   4. Wire markers shall be readable after boot installation.
5. Manufacturers: The following or equal:
   a. Raychem, MCK.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING
   A. As specified in the Commissioning section.

3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION
   A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_21_00
UTILITY COORDINATION

PART 1        GENERAL

1.1         SUMMARY

A. Section includes:
   1. Coordination with the utility companies to provide service.
   2. Contractor's responsibilities for connecting to utilities and providing utility service to the
      facilities.
   3. Descriptions of utility services required.

1.2        REFERENCES

A. As specified in the Common Work Results for Electrical section.

1.3        DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

1.4        SYSTEM DESCRIPTION

A. Electrical service:
   1. Provide all Work and materials and bear all costs for providing temporary construction
      power and the permanent electrical service, including but not limited to:
      a. All Work and materials not provided by the electric utility.
      b. All permits and fees required by the electric utility.
   2. Provide electrical ducts, raceways, conductors and connections indicated on the
      Drawings, and all other Work and materials required for a complete electrical service,
      including but not limited to the following:
      a. Electrical service conduits and conductors from the point of electric utility
         connection to the service entrance equipment.
      b. Metering conduits from the instrument transformers to the meter.

B. Telephone service:
   1. Provide all Work and materials and bear all costs for the telephone service during
      construction:
      a. All permits and fees required by the telephone utility.
   2. Provide the telephone entrance conduit(s) from the terminal pole/pedestal to the
      telephone board, and all other Work and materials required for a complete telephone
      service.

C. General:
   1. Coordinate and obtain inspections and final installation approval from the serving
      utilities and other authorities having jurisdiction.

1.5        SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.
B. Certification:
   1. Submit certification that the intended installation has been coordinated with the utility companies.
   2. Include a narrative description of the utility’s requirements and points of connection, names, and telephone numbers for contacts at the utilities.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. Materials and equipment used in performance of Electrical Work shall be listed or labeled by UL, or other equivalent recognized independent testing laboratory, for the class of service intended.

1.7 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.8 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
   1. Before start of Site Work, make arrangements for temporary telephone and electrical service as required.

B. Electrical systems:
   1. Before bidding, the electrical contractor shall contact the utilities to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.
   2. Before commencing Work, coordinate electric service entrance requirements with local electric utility to ensure that the installation will be complete as specified in these Contract Documents:
      a. Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades.
      b. Arrange for utility revenue meter.
      c. Coordinate installation of metering CTs and PTs furnished by the electric utility.

C. Telephone systems:
   1. Before commencing Work, coordinate complete telephone service:
      a. Verify compliance with telephone utility requirements.
      b. Verify exact location of each service point and type of service.
   2. Coordinate complete telephone line connections at locations indicated on the Drawings with the local telephone utility.

D. Before commencing Site Work, coordinate underground conduit installations with other Work to eliminate conflicts and avoid interferences with other underground systems.

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.
1.12 SYSTEM START-UP
   A. As specified in the Common Work Results for Electrical section.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS (NOT USED)

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS
   A. Furnish materials in accordance with the applicable requirements of the utilities and as specified in these Specifications.

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT
   A. Furnish equipment in accordance with the applicable requirements of the utilities and as specified in these Specifications.

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION
   A. As specified in the Common Work Results for Electrical section.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING
   A. As specified in the Commissioning section.

3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING
   A. As specified in the Common Work Results for Electrical section.

3.11 PROTECTION
   A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_27_20

DRY-TYPE TRANSFORMERS

PART 1  GENERAL

1.1  SUMMARY

A.  Section includes:
   1.  Enclosed dry-type transformers:
       a.  Rated 1 to 1,000 kilovolt-amperes, single and 3-phase,
       b.  Primary voltage 600 volts and below.

1.2  REFERENCES

A.  As specified in the Common Work Results for Electrical section.

B.  Institute of Electrical and Electronics Engineers (IEEE):
    1.  389 - IEEE Recommended Practice for Testing Electronics Transformers and Inductors.
    2.  C57.12.01 - IEEE Standard General Requirements for Dry-Type Distribution and Power
       Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings.
    3.  C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers.

C.  National Electrical Manufacturers Association (NEMA):
    1.  250 - Enclosures for Electrical Equipment (1000 V Maximum).

D.  Underwriters Laboratory (UL):
    1.  1561 - Standard for Dry-Type General Purpose and Power Transformers.

E.  U.S. Department of Energy (DOE):
    1.  10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial
       Equipment.

1.3  DEFINITIONS

A.  As specified in the Common Work Results for Electrical section.

B.  NEMA:
    1.  Type 2 enclosure in accordance with NEMA 250.
    2.  Type 3R enclosure in accordance with NEMA 250.

1.4  SYSTEM DESCRIPTIONS

A.  Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and
    connections as indicated on the Drawings:
    1.  Transformers shall provide full capacity at the Project elevation and environmental conditions
        as specified in the Common Work Results for Electrical section after all derating factors have
        been applied.
    2.  Suitable for continuous operation at full rating with normal life expectancy in accordance with
        IEEE C57.96.

1.5  SUBMITTALS

A.  Furnish submittals as specified in the Common Work Results for Electrical section.
B. Product data:
1. Catalog cut sheets.
2. Nameplate data.
3. Dimensions:
   a. Height.
   b. Width.
   c. Depth.
4. Inrush current.
5. Insulation system and temperature constraints.
6. Number and rating of taps.
7. Sound levels.
8. Connection diagrams:
   a. Primary.
   b. Secondary.
9. BIL rating.
10. Required clearances.
11. Percent impedance.
12. Efficiency.
13. Certification of full capacity capability at the Project elevation and ambient conditions.
14. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in the Common Work Results for Electrical section:
   a. Manufacturer's statement of seismic qualification with substantiating test data.
   b. Manufacturer's special seismic certification with substantiating test data.

C. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category A or B:
   a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
3. For equipment installed in structures designated as seismic design category C, D, E, or F:
   a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in the Common Work Results for Electrical section.
   b. Submit anchoring drawings with supporting calculations.
   c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

1.6 QUALITY ASSURANCE
   A. As specified in the Common Work Results for Electrical section.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS
   A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
   A. As specified in the Common Work Results for Electrical section.
1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
   1. General Electric.
   3. Schneider Electric.
   4. Eaton.
   5. ABB.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.
   3. Material electrical grade:
      a. Copper.

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with IEEE 389 test conditions, not to exceed:

<table>
<thead>
<tr>
<th>Kilovolt-Amperes Range</th>
<th>Audible Sound Level (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9</td>
<td>40</td>
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<tr>
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<tr>
<td>501-700</td>
<td>62</td>
</tr>
<tr>
<td>701-1000</td>
<td>64</td>
</tr>
</tbody>
</table>

3. Taps:
   a. 15 kilovolt-amperes and less:
      1) Two 5 percent full capacity primary taps below rated voltage,
b. 25 kilovolt-amperes and larger:
   1) Four 2.5 percent full capacity primary taps below rated voltage.
   2) Two 2.5 percent full capacity primary taps above rated voltage.
   c. Operated by a tap changer handle or tap jumpers accessible through a panel.

4. Terminals:
   a. UL listed for either copper or aluminum conductors.
   b. Rated for 75 degrees Celsius.

5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with IEEE C57.96.

B. Transformers less than 15 kilovolt-amperes:
   1. Insulation class: 185 degrees Celsius.
   2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:
   1. Insulation class: 220 degrees Celsius.
   2. Temperature rise: 80115150 degrees Celsius, except as noted below:
      a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
   3. Efficiency:
      a. In accordance with DOE 10 CFR Part 431.

D. Enclosures:
   1. Heavy gauge steel:
      a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
      b. Indoor: NEMA Type 2.
   2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
   3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
      a. Neoprene vibration pads and sleeves.

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES

A. Nameplates:
   1. Non-corrosive metal or UL listed non-metallic:
      a. Stamped, engraved or printed with the following information:
         1) Phases.
         2) Frequency.
         3) Kilovolt-ampere rating.
         4) Voltage ratings.
         5) Temperature rise.
         6) Impedance.
         7) Insulation class.
         8) BIL rating.
         9) Connection diagram.
         10) Weight.
         11) Manufacturer.
         12) The identification "transformer".
         13) Classes of cooling.
         14) Tap voltage(s).
         15) Vector diagram.

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)
2.10 FINISHES
A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer’s standard gray enamel rust-inhibiting paint.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION
A. As specified in the Common Work Results for Electrical section.
B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
C. General:
   1. Floor, wall, platform, motor control center, packaged power supply, or roof mounted, as indicated on the Drawings.
   2. Install where not in direct contact with building structure.
   3. Install on single layer vibration pad under the entire mounting surface.
      a. Manufacturers: The following or equal:
         1) Korfund
   4. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.
   5. Ground the enclosure:
      a. To an equipment ground conductor in the conduit.
      b. To the facility grounding electrode system.
   6. Floor mounted transformers:
      a. Install transformers on a housekeeping pads.
      b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer’s recommendations.

3.4 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING
A. As specified in the Commissioning section.
B. Factory tests:
   1. Applied voltage test to each winding and from each winding to the core:
      a. 600-volt class winding 4.5 kilovolt.
   2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
   3. Voltage ratio and polarity.
   4. Sound level, performed in a test room with ambient sound level not exceeding 24 db.
   5. Perform all tests in accordance with UL 1561.
3.8 FIELD QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

3.9 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

3.10 CLEANING

A. As specified in the Common Work Results for Electrical section.

3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_28_50

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. High-energy surge protective devices.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. Institute of Electrical and Electronics Engineers (IEEE):
   2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. Underwriters Laboratory:

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

B. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 4 enclosure in accordance with NEMA 250.
   3. Type 4X enclosure in accordance with NEMA 250.
   4. Type 12 enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. SPD: Surge protective device.
   2. SAD: Silicon avalanche diode.
   3. MOV: Metal oxide varistor.
   4. MCOV: Maximum continuous operating voltage.
   5. \(I_n\): Nominal discharge current.
   6. VPR: Voltage protection rating.
   7. SCCR: Short circuit current rating.

1.4 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.
B. Product data:
   1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
   2. Manufacturer’s catalog cut sheets indicating:
      a. Manufacturer and model numbers.
      b. Ratings of each SPD including but not limited to:
         1) Short circuit current rating.
         2) Nominal discharge current.
         3) Maximum continuous operating voltage.
         4) Voltage protection rating.
         5) System voltage.
         6) System frequency.
         7) Surge current capacity.
   3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
      a. Overcurrent protection.
      b. UL 1449.

C. Shop drawings:
   1. Provide electrical and mechanical drawings by the manufacturer that detail:
      a. Unit dimensions.
      b. Weights.
      c. Components.
      d. Field connection locations.
      e. Mounting provisions.
      f. Connection details.
      g. Wiring diagram.

D. Operation and maintenance manuals:
   1. Provide the manufacturer’s manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.5 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. Institute of Electrical and Electronics Engineers (IEEE C62.41.1, C62.41.2, C62.45, C62.62).

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.

1.7 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.
1.8  SEQUENCING
A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.9  SCHEDULING (NOT USED)

1.10  WARRANTY
A. As specified in the Common Work Results for Electrical section.
B. Extended warranty:
   1. Furnish a manufacturer’s full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer’s written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
   2. Warranty shall include:
      a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
      b. A 24-hour toll-free 800-number for warranty support.

1.11  SYSTEM START-UP
A. As specified in the Common Work Results for Electrical section.

1.12  OWNER’S INSTRUCTIONS (NOT USED)

1.13  MAINTENANCE (NOT USED)

PART 2  PRODUCTS

2.1  MANUFACTURERS
A. One of the following or equal:
   1. Liebert.
   2. Eaton.
   3. Schneider Electric.

2.2  SYSTEM DESCRIPTION
A. Surge protective devices as an integral component of the electrical equipment or externally mounted as indicated on the Drawings.

2.3  EXISTING PRODUCTS (NOT USED)

2.4  MATERIALS (NOT USED)

2.5  MANUFACTURED UNITS
A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.
B. Electrical requirements:
   1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
2. **MCOV:**
   a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
3. **Operating frequency:**
   a. 47 to 63 hertz.
4. **SCCR:**
   a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
   b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
5. **Nominal discharge current Iₙ:**
   a. 20 kA.
6. **Maximum VPR:**

<table>
<thead>
<tr>
<th>Modes</th>
<th>240/120</th>
<th>208Y/120</th>
<th>480Y/277</th>
<th>480V</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-N, L-G, N-G</td>
<td>900</td>
<td>900</td>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td>L-L</td>
<td>1,200</td>
<td>1,200</td>
<td>2,000</td>
<td>2,000</td>
</tr>
</tbody>
</table>

7. **Peak surge current:**
   a. Service entrance locations:
      1) 240 kA per phase minimum.
      2) 120 kA per mode minimum.
   b. Branch locations:
      1) 120 kA per phase, minimum.
      2) 60 kA per mode minimum.

C. **Protection modes:**
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.

D. **Environmental requirements:**
   1. Storage temperature:
      a. -40 degrees to 122 degrees Fahrenheit.
   2. Operating temperature:
      a. 32 degrees to 140 Fahrenheit.
   3. Relative humidity:
      a. 5 percent to 95 percent.
   4. Audible noise:
      a. Less than 45 dBa at 5 feet (1.5 m).
   5. Operating altitude:
      a. Zero to 12,000 feet above sea level.

E. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B and C3 environments, as tested to IEEE C62.45.

2.6 **EQUIPMENT (NOT USED)**

2.7 **COMPONENTS**

A. **Enclosure:**
   1. Located in electrical equipment as indicated on the Drawings.
2. External mounting:
   a. NEMA Type 4X enclosure:
      1) No ventilation openings.
   b. Hinged cover requiring a tool for internal access.
   c. Internal drawing pocket.
   d. All monitoring indications must be visible without opening the door.

B. Internal connections:
   1. Provide low impedance copper plates for intra-unit connections:
      a. Attach surge modules using bolted connections to the plates for low impedance connections.
   2. Size all connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
   1. MOV:
      a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.

D. Overcurrent protection:
   1. Individually fuse all components, including suppression, filtering, and monitoring components:
      a. Rated to allow maximum specified nominal discharge current capacity.
      b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
   1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.8 ACCESSORIES

A. Unit status indicators:
   1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
      a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
      b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:
   1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition:
   1. Provide an alarm On/Off switch to silence the alarm.
   2. A visible LED will confirm whether alarm is On or Disabled.
   3. Locate both switches and the audible alarm on the unit's front cover.

D. Provide an integral disconnect switch located in-line with the SPD enclosure:
   1. External manual operator.
   2. The switch shall disconnect all ungrounded circuit conductors from the SPD.
   3. The integral disconnect switch shall be capable of withstanding, without failure, the maximum published surge current magnitude and short circuit current without failure or damage to the switch.

E. Interconnection cable:
   1. Interconnect the SPD to the power system using a manufacturer furnished assembly of low impedance coaxial cables installed in flexible conduit.
2. Cable designed to transmit transients with minimal voltage drop.
3. UL listed.

2.9 MIXES (NOT USED)
2.10 FABRICATION (NOT USED)
2.11 FINISHES (NOT USED)
2.12 SOURCE QUALITY CONTROL
   A. Permanently affix surge rating to the SPD.
   B. Perform manufacturer's standard factory test:
      1. Perform testing in accordance with UL 1449.

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)
3.2 PREPARATION (NOT USED)
3.3 INSTALLATION
   A. As specified in the Common Work Results for Electrical section.
   B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.
   C. Special techniques:
      1. Install the SPD with as short and straight conductors including ground conductor as practically possible:
         a. Twist the input conductors together to reduce input conductor inductance.
      2. Interconnect the SPD to the power system using a manufacturer supplied interconnection cable consisting of low impedance coaxial cables installed in a flexible conduit.
      3. Do not subject SPD to insulation resistance testing.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)
3.7 COMMISSIONING
   A. As specified in the Commissioning section.

3.8 FIELD QUALITY CONTROL
   A. As specified in the Field Electrical Acceptance Tests section.

3.9 ADJUSTING (NOT USED)
3.10 CLEANING (NOT USED)
3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_41_10
DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Fusible and non-fusible disconnect switches.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. National Electric Manufacturer’s Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment.

C. Underwriters Laboratories Inc. (UL):
   1. 20 - General-Use Snap Switches.
   2. 98 - Enclosed and Dead-Front Switches.
   3. 508 - Standard for Industrial Control Equipment.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

B. Specific definitions:
   1. Safety switches and disconnect switches are to be considered synonymous.

1.4 SYSTEM DESCRIPTION

A. Provide heavy-duty type disconnect switches as indicated on the Drawings and specified in the Contract Documents.

B. Provide disconnect switches with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
   1. Manufacturer.
   2. Manufacturer's specifications and description.
   3. Ratings:
      a. Voltage.
      b. Current.
      c. Horsepower.
      d. Short circuit rating.
   4. Fused or non-fused.
   5. NEMA enclosure type.
6. Dimensions:
   a. Height.
   b. Width.
   c. Depth.
7. Weight.
8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop drawings:
1. Manufacturer's installation instructions:
   a. Indicate application conditions and limitations of use stipulated by product testing
      agency specified under Quality Assurance, Regulatory Requirements below.
   b. Include instructions for storage, handling, protection, examination, preparation,
      installation, and operation of product.
2. Identify motor or equipment served by each switch; indicate nameplate inscription.

D. Installation instructions:
1. Provide anchorage instructions and requirement based on the seismic requirements at
   the Project Site as specified in the Common Work Results for Electrical section and
   calculations:
   a. Stamped by a professional engineer registered in the state where the Project is
      being constructed.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. Regulatory requirements:
   1. NEMA KS1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).
   2. UL 98 - Enclosed and Dead-Front Switches.

C. Disconnect switches shall be UL listed and labeled.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING

A. After successful review of the initial fault current study, submit complete equipment
   submittal.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.
1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
1. Schneider Electric.
2. Eaton.
4. Siemens.
5. Appleton.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT

A. Switch mechanism:
1. Quick-make, quick-break heavy-duty operating mechanisms:
   a. Provisions for padlocking the switch in the Off position.
   b. A minimum of 90-degree handle travel position between Off and On positions:
      1) Provide handle position indicators to identify the handle position.
   c. Full cover interlock to prevent opening of the switch door in the On position and to
      prevent closing the switch mechanism with the door open:
      1) With an externally operated override.

B. Switch interior:
1. Switch blades visible when the switch is Off and the cover is open.
2. Lugs:
   a. Front accessible.
   b. Removable.
   c. UL listed for 60/75-degree Celsius copper conductors.
3. Current carrying parts completely plated to resist corrosion.
4. Removable arc suppressors to facilitate easy access to line side lugs.
5. Furnish equipment ground kits for every switch.

C. Fused switches:
1. UL approved for field conversion from standard Class H fuse spacing to Class J fuse
   spacing:
   a. Ratings 100 amperes through 600 amperes at 240 volts.
   b. Ratings 30 amperes through 600 amperes at 600 volts.
   c. Provide spring reinforced and plated fuse clips.

D. Ratings:
1. UL horsepower rated for AC or DC with the rating not less than the load served.
2. Current:
   a. 30 to 1,200 amperes.
3. Voltage:
   a. 250 volts AC, DC.
   b. 600 volts (30 A to 200 A, 600 volts DC).
4. Poles:
   a. 2, 3, 4, and 6 poles.
5. UL listed short circuit ratings:
   a. 10,000 RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 amperes).
   b. 200,000 RMS symmetrical amperes when used with or protected by Class R or J fuses (30-600 amperes employing appropriate fuse rejection).
   c. 200,000 RMS symmetrical amperes when used with or protected by Class L fuses (800-1,200 amperes).
6. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 26_05_00 - Common Work Results for Electrical for the installed location.

E. Size, fusing and number poles as indicated on the Drawings or as required:
   1. Provide solid neutral where indicated on the Drawings.

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.

C. NEMA Type 7 and 9 enclosures furnished with drain and breather kit when used in outdoor applications.

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3  EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
C. General:
1. Use Myers hubs or bolt-on hubs for all conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
2. Provide all mounting brackets, stands, supports and hardware as required:
   a. Match finish and materials for all brackets, stands, and hardware with the switch installed.
   b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.
3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
   a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.
   b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
4. Provide a nameplate for each disconnect switch:
   a. Provide per requirements specified in the Identification for Electrical Systems section.
   b. Identify voltage, circuit, fuse size, and equipment served on the nameplate.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)
3.7 COMMISSIONING
   A. As specified in the Commissioning section.
3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.
3.9 ADJUSTING (NOT USED)
3.10 CLEANING
   A. As specified in the Common Work Results for Electrical section.
3.11 PROTECTION
   A. As specified in the Common Work Results for Electrical section.
3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 26_41_20
LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Low voltage molded case circuit breakers.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. National Electrical Manufacturers Association (NEMA):
1. AB 3. - Molded Case Circuit Breakers and Their Application.

C. Underwriter’s Laboratories (UL):
1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
2. 943 - Ground Fault Circuit Interrupters.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

B. In accordance with UL 489.

1.4 SYSTEM DESCRIPTION

A. Molded case thermal magnetic or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
1. Catalog cut sheets.
2. Manufacturer’s time-current curves for all molded case circuit breakers furnished.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.7 DELIVERY, STORAGE AND HANDLING

A. As specified in the Common Work Results for Electrical section.
1.8 PROJECT OR SITE CONDITIONS
   A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
   A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP
   A. As specified in the Common Work Results for Electrical section.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. One of the following or equal:
      1. Eaton.
      2. General Electric Co.
      3. Schneider Electric.
      4. ABB.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS
   A. General:
      1. Conforming to UL 489.
      2. Operating mechanism:
         a. Quick-make, quick-break, non-welding silver alloy contacts.
         b. Common Trip, Open and Close for multi-pole breakers such that all poles open
            and close simultaneously.
         c. Mechanically trip free from the handle.
         d. Trip indicating handle - automatically assumes a position midway between the
            manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
         e. Lockable in the "OFF" position.
      3. Arc extinction:
         a. In arc chutes.
      4. Voltage and current ratings:
         a. Minimum ratings as indicated on the Drawings.
         b. Minimum frame size 100A.
      5. Interrupting ratings:
         a. Minimum ratings as indicated on the Drawings.
         b. Not less than the rating of the assembly (panelboard, switchboard, motor control
            center, etc.).
B. Motor circuit protectors:
   1. Instantaneous only circuit breaker as part of a listed combination motor controller.
   2. Each pole continuously adjustable in a linear scale with 'LO' and 'HI' settings factory calibrated.

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS

A. Terminals:
   1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.

B. Case:
   1. Molded polyester glass reinforced.
   2. Ratings clearly marked.

C. Trip units:
   1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
   2. Thermal magnetic:
      a. Instantaneous short circuit protection.
      b. Inverse time delay overload.
      c. Ambient or enclosure compensated by means of a bimetallic element.
   3. Solid state:
      a. With the following settings as indicated on the Drawings.
         1) Adjustable long time current setting.
         2) Adjustable long time delay.
         3) Adjustable short time pickup.
         4) Adjustable short time delay.
         5) Adjustable instantaneous pickup.
         6) Adjustable ground fault pickup as indicated on the Drawings.
         7) Adjustable ground fault delay as indicated on the Drawings.

D. Molded case circuit breakers for use in panelboards:
   1. Bolt-on type:
      a. Plug-in type breakers are not acceptable.
   2. Ground fault trip devices as indicated on the Drawings.

2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer's standard testing procedures.
PART 3  EXECUTION

3.1  EXAMINATION (NOT USED)

3.2  PREPARATION (NOT USED)

3.3  INSTALLATION
   A.  Install breakers to correspond to the accepted shop drawings.

3.4  ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5  REPAIR/RESTORATION (NOT USED)

3.6  RE-INSTALLATION (NOT USED)

3.7  COMMISSIONING (NOT USED)

3.8  FIELD QUALITY CONTROL
   A.  As specified in the Common Work Results for Electrical section.

3.9  ADJUSTING
   A.  Adjust trip settings in accordance with Protective Device Coordination Study as accepted by
       the Engineer and in accordance with manufacturer’s recommendations.
   B.  Adjust motor circuit protectors in accordance with NEC and the manufacturer’s
       recommendation based on the nameplate values of the installed motor.

3.10  CLEANING (NOT USED)

3.11  PROTECTION
   A.  As specified in the Common Work Results for Electrical section.

3.12  SCHEDULES (NOT USED)

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY

A. Section includes:
   1. Panelboards serving feeder circuits and branch circuits.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. Underwriter's Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

1.4 SYSTEM DESCRIPTION

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
   1. Service voltage and configuration as indicated on the panel schedules.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
   1. Manufacturer of panelboard.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase.
      c. Continuous current.
      d. Short circuit interrupting rating.
   4. NEMA enclosure type.
   5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
   6. Furnish circuit breaker submittals as specified in the Low Voltage Molded Case Circuit Breakers section.
   7. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in the Common Work Results for Electrical section:
      a. Manufacturer's statement of seismic qualification with substantiating test data.
      b. Manufacturer's special seismic certification with substantiating test data.

C. Shop drawings:
   1. Drawings to contain:
      a. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
         1) Height.
2) Length.
3) Width.
b. Weight.
c. Anchoring locations.
d. Breaker layout drawing with dimensions:
   1) Location of the main, branches, solid neutral, and ground.
e. Conduit entry/exit locations:
   1) Identify all conduit entry/exit locations and restrictions.
f. Individual panel schedules identifying breaker locations, ratings, and nameplate
designations within the panelboard, for every panelboard.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting
into place.
2. For equipment installed in structures designated as seismic design category A or B:
   a. Provide manufacturer’s installation instructions and anchoring details for
      connecting equipment to supports and structures.
3. For equipment installed in structures designated as seismic design category C, D, E,
or F:
   a. Provide project-specific installation instructions and anchoring details based on
      support conditions and requirements to resist seismic and wind loads as specified
      in the Common Work Results for Electrical section.
   b. Submit anchoring drawings with supporting calculations.
   c. Drawings and calculations shall be stamped by a professional engineer
      registered in the state where the Project is being constructed.

E. Operations and maintenance manual:
1. Provide a complete manual for the operation and maintenance of the panelboard,
circuit breakers, devices, and accessories:
   a. Including but not limited to:
      1) Instruction narratives and bulletins.
      2) Renewal parts lists.
      3) Time-current curves for all devices.

F. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the
panelboard to prove the panelboard is suitable for the seismic requirements at the
Project Site.

1.6 QUALITY ASSURANCE
A. As specified in the Common Work Results for Electrical section.
B. Panelboards shall be UL listed and labeled.
   1. Where indicated as service entrance equipment, panelboards shall be UL labeled and
      listed "Suitable for Service Entrance."

1.7 DELIVERY, STORAGE, AND HANDLING
A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS
A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)
1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
   1. Eaton.
   2. General Electric Co.
   3. Schneider Electric.

B. Circuit breakers:
   1. Same manufacturer as the panelboard.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.

B. Short circuit rating:
   1. Provide panelboards with short-circuit ratings as indicated on the Drawings:
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

2.6 COMPONENTS

A. Enclosure:
   1. NEMA enclosure type as indicated on the Drawings.
      a. Where not indicated on the Drawings, as specified in the Common Work Results for Electrical section for the installed location.
   3. Gutter space in accordance with the NEC:
      a. Minimum of 4 inches of gutter space.
   4. Dead-front, no live parts when the panelboard is in service.
5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.

6. 4-piece front to provide ease of wiring access.

7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull.
   a. Minimum 2 keys per panelboard.
   b. Key all panelboard locks alike.

8. Circuit directory frame and card on the inside of the door.

9. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Dimensions and temperature rise in accordance with UL 67:
         1) Limit current density to less than 1,000 amps per square inch.
      c. Insulate all current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
   3. Ground bus:
      a. Copper, solidly bonded.
   4. Neutral bus:
      a. Provide where indicated on the Drawings.
      b. 100 percent rated.
      c. Provide lugs for each outgoing feeder requiring a neutral connection.
   5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:
   1. UL listed for copper and aluminum wire:
      a. Provide lugs rated for 75-degree Celsius terminations.
      b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified in the Low Voltage Molded Case Circuit Breakers section and as indicated on the Drawings:
   1. Provide all circuit breakers with bolt-on connections:
      a. Plug-in circuit breakers are not allowed.

2.7 ACCESSORIES

A. Surge protective devices:
   1. Furnish panelboards with surge protective devices as indicated on the Drawings.
   2. As specified in the Surge Protective Devices section.

B. Nameplates:
   1. As specified in the Identification for Electrical Systems section,
   2. Install on outside of door.
   3. Indicating:
      a. Panel designation.
      b. Voltage.
      c. Number of phases and configuration.

C. Circuit identification labels:
   1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
2. Type all information on the cards using designations in the panel schedules.
3. Laminated on both sides.

D. Pad locking mechanism:
   1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
   2. At a minimum, provide 1 mechanism per panelboard:
      a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.8 MIXES (NOT USED)
2.9 FABRICATION (NOT USED)
2.10 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer’s standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)
3.2 PREPARATION (NOT USED)
3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Surface, flush or MCC mounted as indicated on the Drawings.
   2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.
   3. Perform work in accordance with the manufacturer’s instructions and shop drawings.
   4. Provide all brackets, hangers, supports, and hardware for mounting as required.
   5. In all NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. Mount panelboard so that top operating handle is not more than 6 feet-7 inches above the operating floor.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)
3.7 COMMISSIONING

A. Factory testing:
   1. Perform standard factory tests on the panelboards:
   2. Test in accordance with the latest version of NEMA and UL standards.

3.8 FIELD QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in the Common Work Results for Electrical section.

3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES

A. Circuiting within the panelboard shall match the panel schedules as indicated on the Drawings.

B. Provide typewritten schedule in each panelboard.

END OF SECTION
SECTION 26_51_00
LIGHTING: LED LUMINAIRES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes: LED luminaires, drivers, poles, and accessories.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. Illuminating Engineering Society of North America (IESNA):
   1. LM-79 - IES Approved Method for the Electrical and Photometric Measurements of
      Solid-State Lighting Products.
   2. LM-80 - IES Approved Method: Measuring Lumen Maintenance of LED Light Sources.
   3. TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power
      Circuits.

D. National Electrical Manufacturers Association (NEMA):
   1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic
      Drivers and Discharge Ballasts.

E. Underwriters Laboratories (UL):
   1. 1598 - Luminaires.
   2. 8750 - Light Emitting Diode (LED) Equipment For Use In Lighting Products.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

B. Specific definitions and abbreviations:
   1. CCT: Correlated color temperature - Scientific scale to describe how "warm" or how
      "cool" the light source is, measured in Kelvin. The lower the Kelvin temperature, the
      warmer the light feels, or appears.
   2. CRI: Color Rendering Index - A quantitative measure of the ability of a light source to
      reveal the colors of various objects faithfully in comparison with an ideal or natural light
      source.
   3. Driver - Device that manages power and controls the current flow from AC to DC for
      an LED lighting product.
   4. Efficacy - Lumen output of a light source per unit of power supplied to that source
      (lumens per watt).
   5. EMI: Electromagnetic Interference - Electrical interference (noise) generated by
      electrical and electronic devices.
   6. FC: Foot Candles - Measure of light level on a surface being illuminated.
   7. L70 - The extrapolated life in hours of the luminaire when the luminous output
      depreciates 30 percent from initial values.
   8. LED: Light emitting diode - A solid-state semiconductor device that produces light
      when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - The international (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by one candle power when all parts of the surface are exactly one foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
15. THD: Total harmonic distortion - The combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

1.4 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section.

B. Product data:
   1. LED Luminaires:
      a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule in the Drawings.
      b. Provide for each luminaire type:
         1) Materials.
         2) Type of diffuser.
         3) Hardware.
         4) Gasketing.
         5) Reflector.
         6) Chassis.
         7) Finish and color.
         8) Driver type and protection.
         9) LED luminaire:
            a) Initial lumen output at 40 degrees Celsius ambient.
            b) Correlated color temperature.
            c) Lumen maintenance factors.
            d) Lumen ambient temperature multipliers.
            e) Drive current.
            f) Efficacy.
      10) Picture of luminaire.
      11) IES optical distributions.
      12) Dimensioned drawings:
          a) Effective projected area rating for pole mounted luminaires.
      13) Weight.
      14) Photometric data:
          a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
          b) Luminaire dirt depreciation factor.
          c) Candlepower distribution curves.
          d) Average luminaire brightness.
          e) Lumen output charts.
      15) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
          a) Support methods shall be based on seismic requirements at the project site as specified in the Common Work Results for Electrical section.
c. Luminaire substitutions:
   1) Provide complete literature for each luminaire substitution:
      2) Submittals for substituted luminaires shall be sufficient for competent
         comparison of the proposed luminaire to the originally specified luminaire:
            a) Photometric data:
               (1) IES file in standard IES format.
               (2) Coefficient of utilization tables based on the IES zonal cavity
                   system by an approved testing laboratory.
               (3) Candlepower distribution curves.
               (4) Average luminaire brightness.
               (5) Lumen output charts.
               (6) Power requirements in watts and volt-amperes.
            b) Calculations:
               (1) Provide software generated calculations showing illuminance
                   levels in footcandles and power usage in watts per square foot for
                   each of the areas in which substitutions are proposed:
                   (a) Use surface reflectance values and luminaire light loss
                       factors approved by the Engineer to perform all calculations.
            c) Specification sheets:
               (1) If lacking sufficient detail to indicate compliance with contract
                   documents, standard specification sheets will not be accepted.
                   This includes, but is not limited to, luminaire type designation,
                   manufacturer's complete catalog number, voltage, LED type,
                   CCT, CRI, specific driver information, system efficacy, L70 life
                   rating, and any modifications necessary to meet the requirements
                   of the contract documents.
               3) Substitutions for specified luminaires will be evaluated upon quality of
                   construction, light distribution, energy use, appearance, and maintenance.
               4) Substitutions shall comply with all applicable building and energy codes.

2. Driver: Provide for each driver type:
   a. Catalog number.
   b. Type of driver.
   c. Output wattage.
   d. Input voltage.
   e. Operating voltage range.
   f. Maximum input power.
   g. Efficiency.
   h. Operating line current.
   i. Power factor.
   j. Operating temperature range.
   k. Current output range in ambient temperatures of 30 to 55 degrees Celsius.
   l. Surge suppression data.

C. Record documents:
   1. Update the Luminaire Schedule in the Drawings to reflect the acceptable substitutions,
      after the substitution has been reviewed and accepted by the Engineer.

1.5 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.
1.7 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.8 SEQUENCING (NOT USED)

1.9 SCHEDULING

A. Exterior and outdoor lighting system operation shall be demonstrated during the hours of darkness.

B. Lighting demonstration shall occur within 2 weeks before substantial completion.

1.10 WARRANTY

A. As specified in the Common Work Results for Electrical section.

B. LED luminaire:
   1. 5 year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

1.11 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.12 OWNER’S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE

A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Luminaires:
   1. The following or equal:
      a. As noted on the Luminaire Schedule.

B. Drivers:
   1. One of the following or equal:
      a. Philips Advance.
      b. Thomas Research.
      c. eldoLED.

C. Substitutions:
   1. The lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor’s responsibility to ensure and prove to the Engineer at time of submittal the substitutions meet the quality and photometric requirements of the original design.
2.2 SYSTEM DESCRIPTION

A. Provide luminaires, and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.

B. Individual luminaire types are indicated on the Drawings and on the Luminaire Schedule.

2.3 EXISTING PRODUCTS (NOT USED)

2.4 MATERIALS (NOT USED)

2.5 MANUFACTURED UNITS (NOT USED)

2.6 EQUIPMENT

A. LED Luminaires:
   1. General:
      a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
      b. Provide the luminaires furnished per the Luminaire Schedule in the Drawings:
         1) The Specifications noted in this Section are an addition or supplement to the Luminaire Schedule.
      c. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
   2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
   3. Minimum rated life:
      a. Office Areas: 70,000 hours when operated at 25 degrees Celsius.
      b. Process Areas: 60,000 hours when operated at 40 degrees Celsius.
      c. Hazardous Areas: 50,000 hours when operated at 40 degrees Celsius.
   4. Minimum efficacy of 70 lumens/watt.
      a. Hazardous Areas: Minimum 60 lumens/watt.
   5. Minimum Color Rendering Index of 70.
   6. Tested according to IESNA LM-79 and LM-80.
   7. Lumen maintenance projection in accordance with IESNA TM-21.
   8. RoHS compliant.
   9. Integral driver.
   10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule.
       a. Wet or damp locations: UL 1598 listed.
   11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.
   12. Exterior/outdoor luminaires:
       a. Luminaires in combination with their mounting pole and bracket shall be capable of withstanding:
          1) Wind levels at the project site without damage.
          2) Seismic levels at the project site.
       b. Corrosion-resistant hardware and hinged doors or lens retainer.
       c. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design.

B. Drivers:
   1. Dimmable, with dimming signal protocol of 0-10 VDC or DALI.
   2. Input power source:
      a. As indicated on the Drawings.
   3. Drive current:
      a. As indicated in the Luminaire Schedule.
4. Power factor: greater than 0.90.
5. Efficiency: greater than 80 percent.
6. Total harmonic distortion (THD) of the input current less than 20 percent.
7. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
8. Minimum operating temperature of 0 degrees Celsius.
9. Sound rating: Class A+ or quieter.
10. UL listed Class 2 Outdoor in accordance with UL 8750.
11. In accordance with IEEE C62.41 Category A for transient protection.
12. Driver must limit inrush current:
   a. Meet or exceed NEMA 410 driver inrush standard:
      1) 230 Amps per 10 Amp load with a maximum of 106 Amps squared-seconds at 120V.
      2) 430 Amps per 10 Amp load with a maximum of 370 Amps squared-seconds at 277V.

2.7 COMPONENTS

2.8 ACCESSORIES (NOT USED)

2.9 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Install luminaires per the manufacturer's guidelines and submitted installation calculations to meet seismic and wind requirements at the project site.

C. Special techniques:
   1. Support luminaires from structural elements capable of carrying the total weight.
   2. Install luminaires plumb and square with building and wall intersections:
      a. Suspend pendant-mounted luminaires that are mounted from sloping ceilings with ball hangers, unless otherwise indicated on the Drawings.
      b. Install luminaires in machinery rooms after machines have been installed, so as to ensure no conflict with machinery, piping, or ductwork.
   3. In all cases, coordinate luminaire locations with work of other trades to prevent obstruction of light from the fixtures:
      a. Locate bottom of luminaire approximately at the bottom of ductwork, unless otherwise specified or indicated on the Drawings.
4. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
5. Provide ceiling or pendant mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.
6. Provide recessed luminaires with auxiliary safety supports attached directly to the building structure:
   a. The safety supports shall consist of number 12 AWG soft drawn galvanized wires.
7. Install luminaires in accordance with the architectural reflected ceiling Drawings:
   a. Center luminaires on ceiling tiles unless otherwise indicated.
8. Support luminaires installed in suspended grid ceilings, independently of the grid:
   a. Provide seismic restraint clips for all luminaires installed in suspended grid ceilings.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
3.5 REPAIR/RESTORATION (NOT USED)
3.6 RE-INSTALLATION (NOT USED)
3.7 COMMISSIONING (NOT USED)
3.8 FIELD QUALITY CONTROL
   A. As specified in the Common Work Results for Electrical section.
3.9 ADJUSTING
   A. Aim and verify all exterior and outdoor luminaires alignment, during dark evening hours, as directed by Owner or the Engineer.
3.10 CLEANING
   A. As specified in the Common Work Results for Electrical section.
   B. Clean all lenses, diffusers, and reflectors.
   C. Refinish all luminaires' trim, poles, and support brackets, where finish has been damaged.
   D. Clean all LED luminaires (new and old), used during construction for construction lighting, before substantial completion.
3.11 PROTECTION
   A. As specified in the Common Work Results for Electrical section.
3.12 SCHEDULES
   A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating and filling.
   2. Preparing subgrades for walks, pavements, and lawns.
   3. Excavating and backfilling for structures and trenches for utilities.
   4. Subbase course for concrete walks and pavements.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.
H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 QUALITY ASSURANCE

A. Pre-excavation Conference: On-site if needed.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. Contractor to coordinate tree and plant protection with Owner at the commencement of construction operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils:

a) 'Soil Classification Groups SC and CL according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter,

2. Plasticity Index:

a) 8 to 18

C. Unsatisfactory Soils: Soil Classification Groups CH, GW, GP, GM, SW, ML, OL, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

D. Bedding Course: Standard Bedding Material per City of Tulsa Standard Specifications.
2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements 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 earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surround area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

3.7 SUBGRADE INSPECTION

A. Proof-roll subgrade with a fully-loaded, tandem-axle dump truck or similar rubber-tired equipment providing an equivalent subgrade loading prior to fill placement or building construction to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. The Contractor shall check moisture content and density of the top 12 inches of subgrade within two days prior to commencement of actual paving operations

B. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting as determined by Owner’s Representative and replace with compacted satisfactory soils. If soft or unstable soils extend to depths greater than 18 inches below the finished pavement subgrade elevation, the Geotechnical Testing Agency should be notified to provide additional stabilization recommendations.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner’s Representative, without additional compensation.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing.
Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course.

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.

2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use engineered fill.

4. Under building slabs, use engineered fill.

5. Under footings and foundations, use engineered fill.
3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.14 GRAADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Grading: Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1/2 inch.

3. Pavements: Plus or minus 1/2 inch.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.

2. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

E. Roadway, Drives and Parking Area Subgrade: In each compacted fill layer, make at least one field density test of subgrade for every 5,000 sq. ft. of paved area, but in no case less than 3 tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section pertains to the provisions for the control of erosion in the construction area and in stockpile areas including seeding, and the construction of temporary swales and sedimentation basins as required and shown on the drawings. All areas where existing vegetation and grass cover have been bared by construction activities shall be protected from erosion.

B. Contractor is responsible for meeting all local, state and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System, Phase II, regulations from the Clean Water Act.

1.2 DEFINITIONS

A. Best Management Practices (BMP’s) means physical facilities schedules of activities, prohibition of practices, maintenance procedures, and other management practices, when properly designed, installed, and maintained, will be effective to prevent or reduce the discharge of pollution associated with construction activities. BMP’s also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. Block Sodding: Sodding for erosion control and for final stabilization shall consist of providing and planting Bermuda grass, Saint Augustine grass, or other acceptable sod along or across such areas as are designated on the drawings and in accordance with the specification requirements herein outlined.

C. Hydromulch Seeding: Seeding, followed by the application of a mulch erosion control blanket shall consist of preparing the ground, sowing of seeds, application of a fertilizer, and stabilization with mulch consisting of a biodegradable fiber along and across such areas as are designated on the plans and in accordance with these specifications.

D. Silt Fence: The reinforced filter fabric barrier consists of geotextile fabric supported by a net reinforced fence stretched across and attached to supporting posts or frame and entrenched. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.

E. Inlet Protection Barriers: The inlet protection barrier consists of a geotextile fabric (filter fabric) supported by a net reinforced fence structure and constructed around a storm drain inlet, catch basin, or culvert. An alternative design of the inlet protection barrier, as approved by the Engineer, consists of fiber rolls placed around a frame, staked in place (or weighted down with clean gravel bags), and constructed around a storm drain inlet, catch basin or culvert. This work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation. As designated on the plans and in accordance with these specifications.
F. Rock Filter Dams: Rock filter dams are temporary berms constructed of stone to intercept and slow storm water runoff to retain sediment on the construction site.

1. Depending upon the type of rock filter dam specified in the construction plans as Type 1, 2, 3, or 4, the aggregate fill may be unwrapped, wrapped in twisted hexagonal wire mesh, or confined in a gabion wire basket. Applications of Rock Filter Dams are as follows:
   a. Type 1 dams may be used at toe of slopes, around inlets, in small ditches, and at dike or swale outlets. Type 1 dams are recommended for erosion and sediment control from a drainage area of 5 acres or less.
   b. Type 2 dams may be used in ditches and at dike or swale outlets.
   c. Type 3 dams may be used in stream flow.
   d. Type 4 sack gabions may be used in ditches and smaller channels to form an erosion and sediment control dam

1.3 QUALITY ASSURANCE

A. Codes and Standards: Install and maintain erosion control systems in compliance with all authorities having jurisdiction.

1.4 PROJECT/SITE CONDITIONS (NOT USED)

1.5 SUBMITTALS (NOT USED)

PART 2 - PRODUCTS

2.1 GRASS

A. Materials for erosion control seeding shall conform to Chapter 200 of the 2009 Oklahoma Department of Transportation Specifications.

B. Materials for erosion control sodding shall conform to Chapter 200 of the 2009 Oklahoma Department of Transportation Specifications.

2.2 FERTILIZER

A. Materials for fertilizing erosion control seeding and/or sodding shall conform to Chapter 200 of the 2009 Oklahoma Department of Transportation Specifications.

2.3 WATER

A. Use clean potable water for maintaining the grass developed after erosion control seeding and/or sodding. Water shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.
B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

C. If onsite reclaimed water sources are used, tanks and appurtenance must be clearly marked with the words "non-potable" water.

2.4 SILT FENCE

A. Geotextile fabric for Silt Fences must meet the section 221.04 of the 2009 Oklahoma Department of Transportation Standard Specifications.

2.5 SILT DIKE

A. Temporary silt dikes shall conform to Chapter 735.07 of the 2009 Oklahoma Department of Transportation Specifications

2.6 INLET PROTECTION BARRIERS

A. Geotextile per 2.5 Silt Fence above.

B. Hardwood Posts shall be 2x2 minimum length 4 feet.

C. Net reinforced fence shall be 2 inch by 4 inch welded wire fabric mesh. The mesh support height shall be the equivalent height, or greater, of the geotextile fabric to be attached.

2.7 ROCK FILTER DAM

A. Materials. Geotextile fabric shall consist of a woven monofilament or spunbond nonwoven fibers consisting of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins. Geotextile fabric shall equal or exceed the following average roll values or as directed by the Engineer:

1. Minimum average roll value.
   a. Elongation - 50 percent.
   b. Grab Strength – 200 pounds.

   c. Puncture Strength – 75 pounds.
   d. UV Stability (retained strength) – 50 percent after 500 hours of exposure.

2. Maximum average roll value.
   a. Apparent Opening Size (AOS) – 0.6 mm/#30 US sieve.

B. Geotextile fabric shall be resistant to commonly encountered soil chemicals, mildew, rot, insects, and deterioration resulting from exposure to sunlight or heat. Geotextile fabric shall provide an expected useable life comparable to the anticipated construction period.

C. Aggregate for the rock filter dams shall consist of crushed stone. Aggregate particles shall be composed of clean, hard, durable materials free from adherent coatings, salt, alkali, dirt, clay,
loam, shale, soft or flaky materials or organic and injurious matter. Aggregate shall be cubic or rounded form, not elongated, flat, shapes. Spalls, fragments, and chips shall not exceed 5 percent by weight. Crushed concrete shall not be substituted for the crushed stone unless as approved by the Engineer. Aggregate size shall depend upon the type of rock filter dam specified in the construction plans. Aggregate size based on type of rock filter dam is as follows:

1. Type 1: 3 inches to 5 inches, open-graded.
2. Type 2: 3 inches to 5 inches, open-graded.
3. Type 3: 4 inches to 8 inches, open-graded.
4. Type 4: 3 inches to 5 inches, open-graded.

D. Mesh is required for reinforced type rock filter dams. Mesh shall be 20 gauge galvanized double twisted hexagonal wire mesh with 1-inch diameter hexagonal openings. Mesh wire shall be zinc coated prior to being double twisted. Reinforcing spiral binders, lacing wire, and stiffeners shall be made of wire having the same coating material and same wire size as the wire mesh. Gabion wire baskets shall equal or exceed the requirements of the wire mesh.

PART 3 - EXECUTION

3.1 GENERAL

A. Protection

1. Protect benchmarks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, existing curbs, and other features indicated on Drawings to remain, or not indicated to be removed, from damage and displacement. If damaged or displaced, notify Engineer and correct defects as directed.

2. Protect above and below grade utilities which are to remain.

B. Preparation:

1. Use all means necessary to control dust on and near the work, and on and near off-site storage, and spoil areas, if such dust is caused by performance of the work of this Section, or if resulting from the condition in which Project Site is left by Contractor.

2. Moisten surfaces, as required, to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on Project Site.

C. Install erosion control systems at the site’s boundary at locations where stormwater runoff will leave the site prior to starting any clearing, stripping, or earthwork operations

D. Minimize the time areas are to be exposed without vegetative cover.

E. Properly dispose of solid waste, paints, solvents, cleaning compounds, etc.

F. Store construction materials in designated areas away from drainageways and low areas.
G. Provide portable toilets and properly dispose of sanitary sewage.

H. Construct containment berms and utilize drip pans at fuel and liquid storage tanks and containers.

3.2 INSTALLATION OF EROSION CONTROL DEVICES

A. Install erosion control devices to protect adjacent and downstream properties from damage and pollution resulting from erosion caused by the work of this Contract.

1. Implement erosion control measures indicated on drawings and additional erosion control measures necessary to prevent damage to adjacent and downstream properties.

B. Install silt fence located along perimeter of site or grading limits immediately following site clearing operations specified under Division 31 Section 31 11 00 Clearing and Grubbing.

1. Install silt fence fabric from a continuous roll for the length of the silt fence whenever possible to minimize the number of joints.
   a. Create joints in fabric by securely fastening fabric at the support post with overlap extending to the next post.

2. Drive support post into ground not less than 18 inches.

3. Excavate a 4 inch wide by 4 inch deep trench on up-slope side of silt fence.
   a. Line trench with silt fence fabric material.
   b. Backfill trench with soil or gravel.

C. Install silt dikes at completion of grading operations in affected area as indicated on drawings in accordance with the Oklahoma Department of Transportation Standard Specifications for Highway Construction, 2009 Edition.

D. Install inlet protection barriers at curb inlets and at area inlets.

E. Rock filter dams shall be installed so as to prevent downstream deposition of sediment and debris from the construction site. Rock filter dams shall be constructed to meet the following criteria:

1. Type 1:
   b. Height: 18-24 inches
   c. Top width: 2 feet minimum.
   d. Upstream and downstream side slope of dam: 2:1 maximum.
   e. Open graded aggregate 3-5 inches.

2. Type 2:
   a. Reinforced with wire mesh.
   b. Height: 18-36 inches.
   c. Top width: 2 feet minimum.
   d. Upstream and downstream side slope of dam: 2:1 maximum.
   e. Open graded aggregate 3-5 inches.

3. Type 3:
a. Reinforced with wire mesh.
b. Height: 36-48 inches.
c. Top width: 2 feet minimum.
d. Upstream and downstream side slope of dam: 3:1 maximum.
e. Open graded aggregate 4-8 inches.

4. Type 4:
a. Reinforced in a gabion wire basket.
b. Height: 30 inches minimum.
c. Top width: 2 feet minimum.
d. Upstream and downstream side slopes of dam: none specified.
e. Open graded aggregate 3-5 inches.

5. The separation geotextile fabric and wire mesh shall be sized and placed in accordance with the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The separation geotextile fabric may be omitted only as approved by the Engineer. The separation geotextile fabric and wire mesh shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel prior to aggregate placement. Sack gabions for Type 4 rock filter dams shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel, as well.

6. Aggregate fill shall be placed to the width, length, height and slopes in accordance with this specification and the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The height of the dam shall be measured vertically from the existing ground to the top of the filter dam. The length of the dam shall be measured across the top centerline of the dam from embankment to embankment and includes the additional length embedded into the embankment. Width of the dam shall be measured along the top face of the dam.

7. Wire mesh shall be folded upstream side over the aggregate fill and tightly secured to itself on the downstream side using wire ties. Hog rings may be substituted for wire ties.

8. Additional aggregate fill or gravel bags shall be placed and secured at the embedded section to prevent low flows from short circuiting the dam at the adjacent dirt embankment area.

9. The Contractor shall be responsible for periodic reshaping, repairing, and maintaining of rock filter dams as directed by the Engineer.

10. The Contractor is responsible for removal and proper disposal of sediment and debris from the rock filter dam. Removed sediment and debris shall not be allowed to flush into the storm sewer system, waterways, jurisdictional wetlands, or onto adjacent properties. Sediment deposits shall be removed before they reach one-third of the height of the dam. Uncontaminated sediment can be placed at the project spoil site or, if properly handled, spread out to supplement fill requirements. If sediment has been contaminated, then it shall be disposed of in accordance with the applicable federal, state, and local regulations. Offsite disposal shall be the responsibility of the Contractor. Contractor is encouraged to reuse aggregate and wire mesh if remaining materials meet original spec requirements.
3.3 EROSION CONTROL SEEDING

A. Exposed fill and stockpile areas shall be protected from windborne erosion if the phasing of the construction operations is anticipated to leave the exposed fill and stockpile areas unattended for 6 weeks or more. At completion of stockpiling operations, stockpiles shall be shaped and graded to drain. Provide a layer of mulch to all sides of the stockpile to protect the stockpile from windborne erosion.

B. Areas designated on the drawings to be seeded shall be seeded in accordance to the Oklahoma Department of Transportation Standard Specifications.

3.4 TEMPORARY SWALES

A. Temporary drainage swales shall be provided as required to carry drainage away from the work area to an approved outfall point.

B. Unless otherwise shown on the drawings, swales shall be earthen "V" shaped channels graded to a sufficient depth and slope to carry the anticipated runoff, but at least two (2) feet deep with a slope of 0.1%.

C. Swales not designated to remain in place at the completion of the contract shall be cleaned of any muck, debris and other unsuitable material and filled with approved fill before final grading operations begin.

D. Swales shall have erosion control barriers as required in these specifications.

3.5 FILL AND CUT SLOPES

A. Fill slopes in all cases shall be no steeper than 3:1 unless specifically stated on the plans or approved by the Owner's Geotechnical engineer.

B. When cut slopes exceed 2:1 for depths over three (3) feet, proper bracing and shoring per OSHA requirements shall be used and maintained.

C. For permanent slopes, cut or fill, between 2:1 and 10:1, erosion protection shall be provided with hydromulch, seeding, sodding, or other method as approved.

D. Where cut slopes of more than 5 feet deep, extend more than 100 feet in length, contractor shall provide a backfill drain at the top of the slope to ease in drainage and erosion control.
3.6 MAINTENANCE

A. Check all erosion control measures after each rainfall event to ensure that they are in proper working order.

1. Immediately restore all measures to installed condition.

2. During the course of construction all temporary swales constructed for this contract shall be maintained so as to allow proper drainage from the construction area. Before Contractor leaves the site at the end of construction, all temporary swales must be reworked to meet final conditions as set forth in the drawings and specifications.

3. The Contractor shall assure that all sub work with other contractors at the site understand the importance of the erosion control features. The Contractor shall require all subcontractors to respect the function of the erosion control features and enlist their coordination in maintaining existing swales and ditches.

B. Inspect silt fences at least once a week.

1. Immediately replace damaged portions of the silt fences, including portions which have collapsed, contain tears, have decomposed, or have become ineffective.

2. Remove sediment deposits, as necessary, to provide adequate sediment storage and to maintain the integrity of fences. Dispose of accumulated sediment by spreading over upland areas of the site.

C. Maintain erosion control devices in place, as specified, until completion of the work of this Contract.

1. At completion of work, inspect all systems, make necessary repairs, remove and dispose of all accumulated sediment, and turn completely operable systems over to Owner for continued maintenance.

D. Where necessary for equipment and vehicular access to the work areas, adequately sized culverts shall be installed and maintained to provide the access without disturbing the site drainage.

3.7 INSPECTIONS

A. Inspect all erosion control systems and devices at least once every seven calendar days.

B. Inspect all erosion control systems and devices within 24 hours of the end of any storm which results in precipitation of 1/2 inch or more.

C. During inspections, locations where stormwater leaves the site shall be inspected for evidence of erosion or sediment deposition.

D. Correct deficiencies within three calendar days.
E. Complete a report of each inspection. Report shall contain the following minimum information:

1. Inspector's name
2. Inspection date
3. Observations of the effectiveness of erosion control systems
4. Actions taken if necessary to correct deficiencies
5. Listing of areas where construction operations have permanently or temporarily stopped
6. Authorized signature

END OF SECTION
1.1 SUMMARY

A. Section Includes:
   1. Cold milling of existing hot-mix asphalt pavement.
   2. Hot-mix asphalt patching.
   3. Hot-mix asphalt paving.
   4. Hot-mix asphalt paving overlay.
   5. Pavement-marking paint.

B. Related Sections:
   1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
   2. Job-Mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the City of Tulsa.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the City of Tulsa Standards for asphalt paving work.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.

2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.


D. Glass Beads: AASHTO M 247, Type 1.
2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by City of Tulsa; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F.

2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
3.6 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 PAVEMENT MARKING

A. Allow paving to age for 30 days before starting pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
   1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roadways.
   2. Ramps/inclines.
   3. Curbs and gutters.
   4. Walks.

1.2 SUBMITTALS

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

B. Other Action Submittals:
   1. 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.

1.3 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.

B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

C. The City of Tulsa Standard Specifications and Standard Details, latest version thereof.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.


C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
E. Deformed-Steel Wire: ASTM A 496/A 496M.

F. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, portland cement Type I/II.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S or Class 4M, uniformly graded. Provide aggregates from a single source.

C. Water: Potable and complying with ASTM C 94/C 94M.


E. 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.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.
2.4 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

2.5 PAVEMENT MARKINGS

A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
   1. Color: As indicated.

B. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
   1. Color: As indicated.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
   3. Slump Limit: 4 inches, plus or minus 1 inch.
   4. Air Content: 6 percent plus or minus 1.5 percent.

B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase surface immediately before placing concrete.
3.2 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.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 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.

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.

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.

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, to match jointing of existing adjacent concrete paving.


3.5 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.

C. 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.

D. Screed paving surface with a straightedge and strike off.
3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.

1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.

2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.
3.8 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
   1. Elevation: 3/4 inch.
   3. Surface: Gap below 10-foot-long, unlevelled straightedge not to exceed 1/2 inch.
   4. Joint Spacing: 3 inches.
   5. Contraction Joint Depth: Plus 1/4 inch, no minus.

3.9 PAVEMENT MARKING

A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. 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.

C. 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
PART 1   GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fence, framework, fabric, and accessories.
   2. Excavation for post bases and concrete foundation for posts.

1.02 REFERENCES

A. City of Tulsa City Standard Specifications.

B. ASTM International (ASTM):
   8. F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. The fence shall match the existing fence surrounding the facility and be in accordance with City of Tulsa Standards.

B. Performance requirements:
   1. Gate operator controls:
      a. In addition to standard controls furnished with gate operators, make provisions for and provide terminal connection points for controls indicated on the Drawings and clearly indicated such connection points on operator control terminal board.
1.04 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Shop drawings:
   1. Remote and automatic gates: Submit drawings showing connection details indicating methods and means of mounting, attaching, and installing operators and locks to gates, including wiring diagrams.

C. Quality control submittals:
   1. Certificates of compliance: Provide certification that materials conform to referenced specifications.
   2. Qualifications: Provide installer’s references and list of local references.
   3. Manufacturer’s instructions: Provide for gate operator equipment.

D. Contract closeout submittals:
   1. Operation and maintenance manuals: Provide for electrical and mechanical equipment.

1.05 QUALITY ASSURANCE

A. Pre-installation conference: Participate in conference, if required.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling: Unload, store, and protect materials such that they are not damaged.

1.07 PROJECT CONDITIONS

A. Field measurements:
   1. Verify actual field distances so that post spacing can be made uniform.
   2. Verify and coordinate gate opening and column distances for driveway.

1.08 SEQUENCING AND SCHEDULING

A. Fences and gates: May be constructed at any time after earthwork, pipe work, and structures to which fence is related has been completed, but prior to erosion control application.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chain link fence and gates: One of the following or equal:
   1. Allied Tube and Conduit.
   3. Approved Equal
2.02 MATERIALS

A. Chain link fence:
   1. Fabric:
      a. Height:
         1) Fence - 8 feet 0 inch.
      b. Mesh: 2 inches.
      c. Size wire: 9 gauge:
         2) Tensile strength: 80,000 pounds per square inch minimum.
   2. Framework: In accordance with ASTM F1043 Group 1A or 1C. Pipe shall be straight and conform to the following weights:

<table>
<thead>
<tr>
<th>Pipe Size Outside Diameter (Inches)</th>
<th>Group IA Weight (Lbs/ft)</th>
<th>Group IC Weight (Lbs/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>9.11</td>
<td>6.56</td>
</tr>
<tr>
<td>6-5/8</td>
<td>18.97</td>
<td>-</td>
</tr>
</tbody>
</table>

a. Top rail:
   1) Tension wire: 7-gauge galvanized coil spring wire.

b. Bottom rail:
   1) Tension wire: 7-gauge galvanized coil spring wire.

c. Line posts:
   1) Size: 2-inch outside diameter.

d. Terminal, corner, and pull posts:
   1) Size: 4-inch outside diameter.

e. Coatings:
   1) Group IA: External coatings in accordance with ASTM F1043 Type A; internal coatings in accordance with ASTM F1043 Type A.
   2) Group IC: External coatings in accordance with ASTM F1043 Type B; internal coatings in accordance with ASTM F1043 Type D.

3. Accessories:
   a. Fence fittings: In accordance with ASTM F626:
      1) Post top fittings:
         a) Provide post caps that fit snugly over posts to exclude moisture. Provide dome style caps for terminal posts and loop style caps for line posts.
         b) Extension arms, 45-degree angle type, capable of receiving 3 strands of barbed wire.
      2) Rail and brace ends: Provide pressed steel or malleable castings that are cup shaped to receive rail and brace ends.

b. Fabric accessories:
   1) Wire clips: Minimum 6 gauge hot-dip galvanized.
   2) Tension bars: 1/4 inch by 3/4 inch, galvanized.
   3) Steel bands: 11 gauge, 1 inch wide, hot-dip galvanized.
   4) Bolts and nuts: 3/8-inch diameter.
   5) Hog rings: 11 gauge.
B. Chain link and barbed wire gates:

1. Gate posts and concrete foundations for gate posts: Except where differently indicated on the Drawings, determine gate posts and concrete foundations for gate posts in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Gate Leaf Widths (Feet)</th>
<th>Gate Posts</th>
<th>Foundations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post O.D.</td>
<td>Diameter</td>
</tr>
<tr>
<td></td>
<td>ASTM F1043 Group IA or IC (Inches)</td>
<td>(Inches)</td>
</tr>
<tr>
<td>0 TO 6</td>
<td>2-7/8</td>
<td>10</td>
</tr>
<tr>
<td>Over 18 to 25</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

2. Chain link gates:
   a. Frames and center supports: 1-7/8-inch outside diameter galvanized steel pipe that in accordance with ASTM F1043 Group IA or IC.
   b. Gate accessories:
      1) Post top fittings:
         a) Provide post caps that fit snugly over posts to exclude moisture.
         b) Provide dome style caps for terminal posts and loop style caps for line posts.
         c) Post top fittings: Extension arms, 45-degree angle type, capable of receiving three strands of barbed wire.
      2) Corner fittings: Heavy pressed steel or malleable castings.
      3) Gate tensioning:
         a) Cross tensioning rods: 3/8 inch, galvanized.
         b) Turnbuckles: Heavy duty.
      4) Tension rods for 4-foot gates: 3/8 inch, easily adjustable, galvanized.
      5) Gate frame corner fittings: Fitting designed for purpose, Manufacturer's standard.
      6) Horizontal gate stiffeners: 1-5/8-inch outside diameter galvanized steel pipe that in accordance with ASTM F1043 Group IA or IC.
      7) Gate hardware:
         a) Catch and locking attachment: Combination steel or malleable iron catch and locking attachment of acceptable design.
         b) Stops:
            (1) Type 1: Capable of holding gates open.
            (2) Type 2: Center rest with catch.

2.03 MANUFACTURED UNITS

A. Special gates:
   1. Swing gates:
      a. Corners of gate frames:
         1) Fasten together and reinforce with fitting designed for purpose or by welding.
         2) Grind weld smooth.
      b. Gate stiffeners: Provided as follows:
         1) On gates 12 feet and wider: Vertically on gates at 6 feet on center.
         2) On gates over 7 feet in height: Horizontally.
c. Gates with fabric 7 feet or more in height:
   1) Install vertical stiffeners at maximum of 8-foot centers.
   2) Install adjustable tension rod on gates over 4 feet in width.
   3) Chain link fence fabric: Attach to gate frame by use of tension bars
      and tie wires as specified for fence construction, and suitable tension
      connectors spaced at approximately 16-inch intervals.

d. Gate tensioning: Provide gates with cross tensioning rods and turnbuckles
   rigidly attached to gate frame.

e. Gate hardware: Provide each pair gates with following:
   1) Catch and locking attachment.
   2) 2 Type 1 stops and 1 Type 2 stop as indicated on the Drawings.

2.04 EQUIPMENT

A. Post mounted gate locks: Provide locks that:
   1. Are electrically operated, post mounted type, and capable of positively locking
      gates to latch post.
   2. Include manual key lock for disconnect in event of power failure.
   3. Are designed to operate on 120 volts alternating current and that are suitable
      for outdoor use.
   4. Manufacturers: The following or equal:
      a. Stanley Vemco, Number 420-141 for slide gate.

2.05 FABRICATION

A. Shop finishing:
   1. Galvanizing: For items not fabricated of galvanized materials hot-dip galvanize
      products after fabrication in accordance with following as applicable:
      a. ASTM A123.
      b. ASTM A153.
      c. ASTM A385.
   2. Mark galvanized products with name of galvanize, applicable ASTM designa-
      tion, and weight of zinc coating.
   3. Galvanize fabricated items complete, or in largest practicable sections.
   4. Provide galvanizing at rate of 2.0 ounces per square foot, minimum.
   5. Hardware:
      a. Padlocks: Cadmium plated.
      b. Chain: Galvanized.
      c.

B. Finish schedule:
   1. Ferrous metal:
      a. Typical: Clean, then hot-dip galvanize in accordance with galvanizing
         standards.

C. Field finish touch-up painting:
   1. Galvanized repair paint: Apply paint having minimum dry film thickness of 2.0
      to 3.5 mils.
PART 3  EXECUTION

3.01  EXAMINATION

A. Verification of conditions: Verify field conditions prior to construction.

3.02  PREPARATION

A. Surface preparation:
   1. Before locating fence posts grade ground to permit grade of fence to remain constant over any local elevations or depressions in ground line.

3.03  INSTALLATION

A. Chain link fences and gates:
   1. General:
      a. Install chain link fence and gates as indicated on the Drawings and specified in this Section.
      b. Provide fence systems that are plumb, taut, true to line and grade, and complete in all details.
      c. Install fencing to generally follow finish grade of ground and provide pull posts at points where required to conform to change in grade.
      d. Install fencing such that space between bottom of fence and finish ground line does not exceed 3 inches.
   2. Concrete foundation for fence posts:
      a. Set fence posts in concrete foundations, that extend at least 3 feet into ground, and space posts not over 10 feet apart.
      b. Provide concrete foundations having minimum of 10 inches in diameter for line posts and 12 inches in diameter for corners and gates.
      c. Provide foundations that extend minimum of 1 inch above finish grade and have tops that are shaped to slope to drain away from posts.
      d. Trowel finish tops of footings, and slope or dome to direct water away from posts.
      e. Set keepers, stops, sleeves, tracks, eye bolts, and other accessories into concrete as required.
      f. Wheel rolling area for sliding gates shall be steel-trowel smooth finish concrete.
   3. Post bracing:
      a. End corner, pull, and gate posts: Brace with same material as top rail and trussed to line posts with 3/8-inch rods and tighteners.
      b. Bracing end, corner, slope, and gate posts:
         1) Brace to midpoint of nearest line post or posts with horizontal braces used as compression members.
         2) Then from such line posts truss from brace back to bottom of end, corner, slope, or gate post with 3/8-inch steel truss rods with turn-buckles or other suitable tightening devices used as tension members.
   4. Top rail:
      a. Where top rail is omitted, use top and bottom tension wire.
   5. Fabric:
a. Place fabric on outward facing side of the posts and install so that top edge projects over top rail of fence.
b. Stretch fabric taut and securely fasten to posts, top rail, and bottom tension wire.
c. Install tension wire parallel to line of fabric.
d. Fabric: Connect fabric to:
   1) Line posts with wire clips minimum every 14 inches.
   2) Terminal, corner, and gate posts with tension bars tied to posts minimum 14 inches on center and with steel bands and bolts and nuts.
   3) Tension wires with hog rings minimum 24 inches on center.
6. Post top fittings: Provide post tops with extension arms.
7. Swing gates:
   a. Provide chain link fencing with swing gates, unless otherwise indicated on the Drawings or specified in this Section.
   b. Provide swing chain link gates where indicated on the Drawings.

3.04 FIELD QUALITY CONTROL
A. Manufacturer's field service: Manufacturer shall check and test all powered gates and accessories before acceptance.

3.05 ADJUSTING
A. Adjust gate travel, stops, and operator position to meet field conditions.

3.06 CLEANING
A. Clean up surplus dirt, concrete, and other waste material and dress grade up upon completion of the work.

3.07 PROTECTION
A. Protect installed fences and gates against damage and, if damaged, repair prior to final acceptance.

END OF SECTION
SECTION 33_05_16.01A
PIPE TRENCH COVERS

PART 1  GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals governed by this section necessary to install the Trench Covers as specified herein.

B. Portions of the project as Bid in the Base Bid, Portion of the project in the Add Alternates.

C. The Owner will select the actual section of Trench Cover to be Replaced.

D. This section includes the following:
   1. Trench Covers.
   2. Support Framework.
   3. Installation.

1.02 DESIGN CRITERIA

A. Design load is considered as uniform loading over the entire cover system. Design live loads of shall be in accordance with the following minimum design loads:
   1.  60 psf live load (non-emergency exit walkways).
   2.  300 lb concentrated load (on 12" x 12" area).

B. Cover shall not deflect more than 3/8" or not deflect more than L/240 of span unless specifically stated otherwise in drawings and/or supplementary conditions. Connections shall be designed to transfer the design loads.

C. Covers weakened by penetrations, cuts, etc. shall be stiffened or reinforced as necessary to restore their capacity to withstand the specified loading and deflection limits.

1.03 SUBMITTALS

A. Shop Drawings and calculations:
   1. Typical cross section.

B. Engineering layout drawings to assist field installation including dimensions and location of each trench.

C. Detail shop drawings showing:
   1. Dimensions.
   2. Sectional assembly.
   3. Location and identification mark.
   4. Size and type of supporting frames required.
D. Quality control and Installation:
   1. Manufacturer’s instructions.

1.04 QUALITY ASSURANCE

A. The material covered by these specifications shall be furnished by an ISO-9001 certified manufacturer of proven ability who is regularly engaged in the manufacture, fabrication, and installation of Trench Cover systems.

B. Substitution of any component or modification of system shall be made only when approved by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Provide Trench Covers as indicated on the Drawings and specified in this Section.
   2. Check and verify dimensions prior to manufacture to ensure proper fit.
   3. Provide embedment as indicated on the Drawings.
   4. Provide cover as indicated on the Drawings.
   5. Structural design calculations for trench covers and accessories.
   6. Provide embedded edge supports for the Trench Covers.

2.02 MATERIALS

A. Concrete:
   1. Class 4,000 psi concrete as specified – Concrete Paving.

B. Reinforcement support chairs:
   1. Hot-Dip Galvanized Steel: Provide hot-dip galvanized steel with plastic tips at surfaces which will be exposed to view. Use unless otherwise indicated on the Drawings.

C. Embedment:
   1. Fiber Reinforced Plastic support angle. As indicated on the drawings.

D. Covers:
   2. Recessed to be flush with the top of side wall support frame.

E. FRP Covers:
   1. The FRP covers shall be manufactured by the pultrusion process. The covers shall be 2" deep and 24" wide with interlocking joints on outside legs of plank. The glass fiber reinforcement for the planks shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. A synthetic surface veil shall be the outermost layer covering the exterior surfaces.
2. Fiberglass planks shall be made from a fire retardant premium polyester resin system that meets the flame spread rating of 25 or less in accordance with ASTM E-84, flammability characteristics of UL 94 V0 and meets the self-extinguishing requirements of ASTM D635. UV inhibitors are added to the resin.
3. The individual cover weight shall be able to be lifted comfortably by two men, one on each end.
4. Color shall be slate gray.

F. PMC Covers:
1. Precast polymer concrete matrix shall be comprised of a thermosetting resin system and inorganic aggregate.
2. The polymer concrete matrix shall not contain Portland cement.
3. Reinforcement: FRP Bar in accordance with ACI-440.1R-06 (most current) design practices based on specific project needs.
4. The cover thickness of precast polymer concrete structures shall not be less than that prescribed by the manufacturers design.
5. Each precast polymer concrete cover component shall be free of all defects, including indentations, cracks, and foreign inclusions that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection.
6. Marking and Identification – Each manhole shall be marked with the following information – Manufacturer’s name and/or trademark, and Production Date.
7. Minimum clearance between wall penetrations and edges shall be per manufacturer’s design.
8. The individual cover weight shall be able to be lifted comfortably by two men, one on each end.

2.03 PHYSICAL PROPERTIES

A. Design:
1. The top surface of all planks shall have a non-skid grit.
2. Planks shall be fabrication to the sizes show on the drawings.

B. Reinforcement:
1. In accordance with ASTM A615 grade 60.

C. Approved Manufacturers:
1. STRONGWELL FRP
2. Trenwa PMC
3. Hubbell PMC
4. Or Approved Equal.

2.04 ACCESSORIES

A. Lifting inserts, covers:
1. Lifting inserts: Have minimum factor of safety of 3 at worst possible working conditions.
PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

3.02 INSTALLATION, GENERAL

A. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing trench covers to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as determined by the Design Engineer.

B. Cutting, fitting and placement: Perform cutting, drilling, and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; measured from established lines and levels.

3.03 ADJUSTING

A. General: Remove any cover that is structurally damaged in handling from any cause from project site and replace with structurally sound unit.

END OF SECTION
SECTION 33 4100  UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Pipe outlets

1.2 DEFINITIONS

A. RCP: Reinforced Concrete Pipe
B. ODOT: Oklahoma Department of Transportation

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Reinforced Concrete Pipe

PART 2 - PRODUCTS

2.1 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III and Class IV for gasketed joints; gaskets: ASTM C 443, rubber.

2.2 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
   1. Cement: ASTM C 150, Type II.

B. Portland Cement Design Mix: Class AA, 4,000 psi minimum with 0.45 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615, Grade 60 (420 MPa) deformed steel.

2.3 PIPE OUTLETS

A. End Treatments: Precast reinforced concrete, with apron and tapered sides.
2.4 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

2.5 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 according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

2.6 PIPE JOINT CONSTRUCTION

2.7 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "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.

2.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate 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 according to requirements of the City of Tulsa.

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 according to requirements of the City of Tulsa Standard Specifications.

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.

END OF SECTION
SECTION 40_67_01

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

PART 1  GENERAL

1.01  SUMMARY

A. Section includes:
   1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
      a. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs).
      b. Control panel installation.

B. Provide all control panels identified in Contract Documents.

1.02  REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   2. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

B. International Electrotechnical Commission (IEC):

C. Underwriters Laboratories Inc. (UL):
   1. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.
   2. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
   3. 508 - Standard for Industrial Control Equipment.
   4. 508A - Standard for Industrial Control Panel.
7. 1283 - Standard for Electromagnetic Interference Filters,

1.03 DEFINITIONS

A. Specific definitions:
   1. The term "panel" in this Section is interchangeable with the term "enclosure."

1.04 SUBMITTALS

A. Provide a control panel hardware submittal for each control panel/enclosure being
   provided on this project, including but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer's literature and specification data sheets for each type of
         equipment to be installed within or on the panel or enclosure.
   2. Shop drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel
         layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by Engineer. The Engineer has
            the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Provide installation details based on calculated shear and tension forces:
         1) Calculations shall be signed and sealed by a Professional Engineer
            licensed in the state where the cabinets and panels will be installed.
      b. For assembled enclosures and other equipment with a weight of
         200 pounds or more, provide calculations for:
         1) Weight including panel internal components.
         2) Seismic forces and overturning moments.
         3) Shear and tension forces in connections.
      c. Cooling calculations, including but not limited to:
         1) Highest expected ambient temperature for the enclosure's location.
         2) Internal heat load.
         3) Exposure to direct sunlight.
         4) Dimensions of the enclosure in inches.
         5) Maximum allowable temperature inside the enclosure, based on the
            lowest operating temperature limit of the installed components.

1.05 QUALITY ASSURANCE

A. Assemble panels, enclosures, along with all internal and external devices, wiring,
   equipment, and materials in a facility that is recognized by UL to assemble and
   certify UL-labeled control panels:
   1. Provide all components and equipment with UL 508 listing.
   2. Provide fuses for all equipment that is not UL or UR listed.

1.06 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including, but not
   limited to, material compatibility, site altitude, site seismic conditions, humidity, and
   process and ambient temperatures.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As listed below in the individual component paragraphs.

B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 SYSTEM DESCRIPTION

A. Panel dimensions:
   1. Minimum dimensions are 30-inches Wide, 30-inches tall and 24-inch It is the responsibility of the Contractor or manufacturer to design and size all panels:
      a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.

B. Structural design:
   1. Completed and installed panel work shall safely withstand seismic requirements at the project. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

2.03 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
   1. Enclosures shall have the following properties:
      a. NEMA Type 4X: Type 316 stainless steel.

B. Bolting material:
   1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
   2. Carriage bolts for attaching end plates.
   3. All other bolted joints shall have S.A.E. standard lock washers.

2.04 MANUFACTURED UNITS

A. Panels/enclosures:
   1. Manufacturers: One of the following or equal:
      a. nVent/Hoffman.
      b. Saginaw Control & Engineering.
      c. Rittal.
   2. Panel assembly:
      a. General guidelines for panel fabrication include:
         1) Continuous welds ground smooth.
         2) Exposed surfaces free of burrs and sharp edges.
b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

<table>
<thead>
<tr>
<th>Enclosure Height (inches)</th>
<th>Minimum Enclosure Steel Thickness (gauge)</th>
<th>Minimum Back Mounting Panel Thickness (gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted up to 48</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

c. Use heavier sheet metal to meet seismic requirements at the project. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.

d. Door construction:
   1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
   2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
   3) Heavy-gauge stainless steel hinges.
   4) For NEMA Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
   5) Gasket installed to seal against roll lip on the enclosure opening.

e. Latches:
   1) For panels, provide each door with an oil tight 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom:
      a) Provide padlock for each enclosure with padlock provisions.
      b) Provide 2 keys per panel.
      c) All locks keyed alike.
   2) For cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.

f. Panel cut-outs:
   1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
   2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors:
      a) Reinforce around cut-outs with steel angles or flat bars.

3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
   a. Minimum 16-gauge, Type 304 stainless steel.
   b. Captive stainless steel cover screws threaded into sealed wells.
   c. Inside finish: White polyester powder coating.

4. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
   a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
   b. Door hardware: Stainless steel.
   c. Provide factory installed rain canopy and sun shield for all enclosures.
B. Arrangement of components:
   1. Arrange panel internal components for external conduit and piping to enter into panel from below.
   2. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
   3. All control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:
   1. Main overcurrent device:
      a. Control panels supplied with 120 VAC:
         1) Provide an internal breaker with the line side terminals covered by a barrier.
         2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
         3) Provide a nameplate prominently positioned on the control panel stating "CAUTION Risk of Electric Shock – UPS equipment outputs remain energized with main disconnect in off position" for any panel containing a UPS.
      b. Provide circuit breakers.
   3. Selection and ratings of protective devices:
      a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
      b. Voltage rating: Not less than the voltage of the application.
      c. Select current rating and trip characteristics to be suitable for:
         1) Maximum normal operating current.
         2) Inrush characteristics.
         3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
      d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant:
         1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
         2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
         3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.
   4. Provide a separate protective device for each powered electrical device:
      a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
      b. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
   5. Fuses for analog and discrete control loops:
      a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
         1) Label shall not cover or interfere with equipment manufacturer's instructions.
b. Provide fuses rated for the voltage and available short-circuit current at which they are applied.

c. Manufacturers: One of the following or equal:
   
   1) Ferraz Shawmut.
   2) Littelfuse.
   3) Bussmann.

6. Fuse holders:
   
   a. Modular type:
      
      1) DIN rail mounting on 35-millimeter rail.
      2) Touch-safe design: All connection terminals to be protected against accidental touch.
      3) Incorporates blown-fuse indicator.
      4) Plug-in style fuse terminals and fuse plugs are not acceptable.

   b. Provide nameplate identifying each fuse.

   c. Manufacturers: One of the following or equal:
      
      1) Phoenix Contact, UT4-HESI Series.
      2) Allen-Bradley, 1492-FB Series B.

7. Control circuit breakers:
   
   a. DIN rail mounting on 35-millimeter rail.
   c. Rated for 250 VAC.
   d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
   e. Current ratings: As required for the application.
   f. Provide nameplate identifying each circuit breaker.
   g. Manufacturers: One of the following or equal:
      
      1) Phoenix Contact, TMC Series.
      2) ABB.
      3) Allen-Bradley.
      4) Square D.

8. Electronic circuit protectors:
   
   a. Used where a NEC Class 2 power circuit is required.
   b. Confirms to NEC Class 2 according to UL 1310.
   c. DIN rail mounting on 35-millimeter rail.
   d. Power source:
      
      1) Operating voltage: 24 VDC.
      2) Output current ratings: As required for the application.
      3) Maximum output current: 4 A.
      4) Maximum nameplate rating: 100VA.
   e. LED for status indication.
   f. Remote status contact.
   g. When using multi-channel electronic circuit protectors, distribute devices such that a failure is limited to a single network or segment.
   h. Provide nameplate identifying each circuit electronic circuit protector module.
   i. Manufacturers: One of the following or equal:
      
      1) Single-channel:
         
         a) Phoenix Contact, PTCB E1 series.
         b) Allen-Bradley, 1694 series.
      2) Multi-channel:
         
         a) Phoenix Contact, CBMC series.
         b) Puls PISA11 series.
D. Conductors and cables:

1. Power and control wiring:
   b. Insulation: 600 VAC type MTW.
   c. Minimum sizes:
      1) Primary power distribution: 12 AWG.
      2) Secondary power distribution: 14 AWG.
      3) Control: 16 AWG.
   d. Color:
      1) AC power (line and load): Black.
      2) AC power (neutral): White.
      3) AC control: Red.
      4) AC control: Orange for foreign voltages.
      5) DC power and control (ungrounded): Blue.
      6) DC power and control (grounded): White with Blue stripe.
      7) Ground: Green.

2. Signal cables:
   b. Insulation: 600 VAC, PVC outer jacket.
   c. Minimum size: 18 AWG paired triad.
   d. Overall aluminum shield (tape).
   e. Copper drain wire.
   f. Color:
      1) 2-Conductor:
         a) Positive (+): Black.
         b) Negative (-): White and red.
      2) 3-Conductor:
         a) Positive (+): Black.
         b) Negative (-): Red.
         c) Signal: White.

   g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:

1. Identify each conductor and cable with unique wire numbers.
2. Readily identified without twisting the conductor.

F. General wiring requirements:

1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
2. Install all components in accordance with the manufacturer’s instructions included in the listing and labeling.
3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
5. Provide power surge protection for all control panels.
6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
7. Provide non-metallic ducts for routing and organization of conductors and cables:
   a. Provide wiring separation plan.
   b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
   c. Provide separate ducts for signal and low-voltage wiring from power and 120 VAC control wiring:
      1) 120 VAC: Grey colored ducts.
      2) 24 VDC: White colored ducts.
8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
   a. Screw-on cable tie mounts.
   b. Hammer-on cable-tie mounting clips.
   c. Fingers of the nonmetallic duct.
9. Wire ties:
   a. No wire ties inside wire duct.
   b. Use Panduit Cable tie installation tool, with tension control/cutoff.
   c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.
12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
   a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
14. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:
   a. Truck Scale.
   b. Printer.
   c. Instruments both mounted in the control panel and remotely connected to the control panel.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Thermal management:
   1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range 40 deg F and 90 deg F.
   2. Air conditioner:
      a. Provide solid-state cabinet coolers or air conditioning units on all outdoor panels.
      b. Provide filters on intake and exhaust openings.
      c. Increase panel sizes as needed to accommodate cooling units.
      d. Enclosure rating: NEMA Type 4X.
      e. Power supply: 120 VAC.
      f. Manufacturers: The following or equal:
         1) Kooltronic, Guardian DP Series.
         2) ICEQube, Blade series or IECEx/ATEX for Zones 1 and 2.
3. Heating:
   a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters.

B. Terminal blocks:
   1. DIN rail mounting on 35-millimeter rail.
   2. Rated for 15 amperes at 600 volts.
   3. Screw terminal type.
   4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
   5. Finger-safe protection for all terminals for conductors.
   6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
   7. Terminals: Plainly identified to correspond with markings on the diagrams:
   8. Disconnect-type field signal conductor terminals with socket/screw for testing.
   9. Identify terminals suitable for use with more than 1 conductor.
   10. Position:
       a. So that the internal and external wiring does not cross.
       b. To provide unobstructed access to the terminals and their conductors.
   12. Manufacturers: One of the following or equal:
       a. Phoenix Contact, UT4 Series.
       b. Phoenix Contact UT6 Series, Allen-Bradley Bulletin 1492 Double-level,
          Weidmüller Klippon V-series, multi-level (screw terminal) terminal blocks.
       c. Allen-Bradley, 1492 Series.

C. DIN rail grounding:
   1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
      a. Mount to DIN rail via grounding foot with mounting screw.
      b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
      c. Not be used for grounding signal cable shields.
   2. Screw terminal type.
   3. DIN rail mounting on 35-millimeter rail.
   4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
   5. Finger-safe protection for all terminals for conductors.
   6. Terminals: Plainly identified to correspond with markings on the diagrams:
   7. Manufacturers: One of the following or equal:
      a. Phoenix Contact, USKLG Series.
      b. Allen-Bradley, 1492-JG Series.

D. Wire duct:
   1. Provide flame retardant plastic wiring duct, slotted with dust cover.
   2. Type:
      a. Wide slot.
      b. Narrow slot.
3. Manufacturers: The following or equal:
   a. Panduit.
   b. Phoenix Contact.
   c. Thomas & Betts.
   d. Iboco.

E. DIN rail:
   1. Perforated steel.
   2. 35 mm width.
   3. 15 mm deep.
   4. Provide 2-inch offset using one of the following:
      a. Offset brackets.
      b. Preformed standoff DIN Rail Channel.

F. Surge protection devices (SPD):
   1. 120 VAC control panel power SPD:
      a. Provide SPD for panel 120 VAC power entrances:
         1) Non-faulting and non-interrupting design.
         2) Provide line to neutral and neutral to ground surge protection.
      b. Provide surge protection at secondary of main circuit breaker:
         1) Surge protection is not required for 120 VAC circuits that are only
            used for panel lights and receptacles.
         2) For panels receiving power at 480 VAC, provide surge protection on
            the 120 VAC control power transformer secondary.
      c. DIN rail mounting.
      d. Attach wiring to the SPD by means of a screw-type cable-clamping
         terminal block:
         1) Gastight connections.
         2) Visual status indication of MOV status on the input and output
            circuits.
         3) Dry contact rated for remote status indication.
      e. Approvals:
         1) Tested in accordance with IEC 61643-11.
         2) Tested in accordance with UL 1283.
         3) Tested in accordance with UL 1449.
         4) Surge protection minimum requirements: Withstand a minimum
            10-kA test current of an 8/20 μs waveform in accordance with IEEE
            C62.41.1 Category C Area.
      f. Manufacturers: One of the following or equal:
         1) Phoenix Contact, Type SFP Filter.
         2) Sola HD, STFE Elite series.
         3) Rockwell, 4983-DC series.
         4) ASCO, Model 277.
      g. Manufacturers: One of the following or equal:
         1) Phoenix Contact, Plugtrab PT-IQ Series.
         2) Dehn, Blitzductor XTU Series.

2.07 ACCESSORIES

A. Provide panels with an inside protective pocket to hold the panel drawings. Ship
   panels with 1 copy of accepted Shop Drawings including, but not limited to,
schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

B. Provide floor stands or legs with a minimum height of 12 inches where needed to center the Panel at eye level.

C. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

D. Provide nameplate to each panel:
   1. Provide a nameplate with the following markings that is plainly visible after installation:
      a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
      b. Supply voltage, phase, frequency, and full-load current.
      c. Power source or circuit ID.
      d. Short-circuit current rating of the panel based on one of the following:
         1) Short-circuit current rating of a listed and labeled assembly.
         2) Short-circuit current rating established utilizing an approved method.

E. Provide a window kit to observe the printer inside the enclosure. The window shall meet the following requirements:
   1. Safety plate glass.
   2. Secured by rubber locking seal.
   3. Allow full viewing of devices issuing visual process data or diagnostics.

F. Lighting:
   1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
      a. Covered or guarded.
      b. Provide On-Off door-activated switches.
      c. 120-volt, single-phase, 15-amp style plug.
      d. Provide 4,000 K, 900 Lumens LED fixture.

G. Receptacles:
   1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
   2. GFCI, 120-volt, single-phase, 15-amp style plug.
   3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.

H. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment grounding busbar with lugs for connection of all equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
   2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND", the letter "G", or the color green.
   3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
8. Unless otherwise noted, connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.

I. Provide sunshades and insulation for all outdoor installations.

2.08 FINISHES

A. Finishes:
   1. Stainless steel:
      a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum.

B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

C. Provide floor stand kits for wall-mounted enclosures.

D. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

E. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.

F. Protect all wiring from sharp edges and corners.
G. Side panels:
   1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.03 CLEANING

A. Clean enclosure and remove debris.

END OF SECTION
SECTION 43_25_00.10

SUBMERSIBLE PROCESS LIQUID SUMP PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Packaged submersible sump pump, with a control panel and instrumentation.

B. Truck Scale Manufacturer specified in Section 10_88_01_Industrial Weighing Scales shall be responsible to procure and provide manufacturers field services for the following:
   1. Sump Pump as specified in this section
   2. Level sensors as specified in this section.
   3. Local control panel as specified in this section.
   4. Items shall be shipped loose for installation by contractor.

C. Truck Scale Manufacturer shall be responsible to coordinate the size of the sump pump with the size of the sump pump pit as indicated on the drawings and specified in Section 01_35_73 Delegated Design Procedures.

D. Contractor shall be responsible to procure, install, test, commission and place into successful working operation in accordance with the design of the Truck Scale Manufacturer the following:
   1. 2-inch check valve as specified in this section
   2. 2-inch ball valve as specified in this section.
   3. ½ inch discharge pressure gauge with gauge isolation as specified in this section
   4. 2-inch discharge piping and supports as specified herein.
   5. All conduit, wire, fasteners, boxes, etc. as necessary to provide 120V, 1ph, 60 Hz power from panel TS-1 to the Local Control panel as indicated on the drawings and specified herein.

E. Contractor shall be responsible for coordinating with the manufacturer to install, test, and commission the sump pump and local control panel as indicated on the drawings and specified herein.

1.02 REFERENCES

A. ASTM International (ASTM):

B. Hydraulic Institute (HI):
   1. 9.1-9.5 - Pumps - General Guidelines.
   2. 11.6 - Rotodynamic Submersible Pump Test.
4. 14.3 - Rotodynamic Pumps for Design and Application.

C. National Electrical Code (NEC).

D. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

E. Underwriters Laboratories, Inc. (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panels.
   3. 698A - Standard for Industrial Control Panels Relating to Hazardous
      (Classified) Locations.
   4. 1283 - Standard for Electromagnetic Interference Filters.
   5. 1449 - Surge Protective Devices.

1.03 SUBMITTALS

A. Submit as specified.

B. Product data: Manufacture’s Product Data.

C. Shop drawings: Manufacturer’s Product Data.

D. Vendor operation and maintenance manuals: QUALITY ASSURANCE.

E. Control Panels: Provide a control panel hardware submittal for each control
   panel/enclosure being provided on this project, including but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer’s literature and specification data sheets for each type of
         equipment to be installed within or on the panel or enclosure.
   2. Shop drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel
         layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by Engineer. The Engineer has
            the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Cooling calculations, including but not limited to:
         1) Highest expected ambient temperature for the enclosure’s location.
         2) Internal heat load.
         3) Exposure to direct sunlight.
         4) Dimensions of the enclosure in inches.
         5) Maximum allowable temperature inside the enclosure, based on the
            lowest operating temperature limit of the installed components.

F. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support
      conditions and requirements to resist loads specified in Section 01_35_73-
      Delegated Design:.
      a. To structures for equipment installed in structures designated as seismic
         design category C, D, E, or F.
b. For equipment installed outdoors.
c. For wall mounted equipment weighing 125 pounds or more.

1.04 WARRANTY

A. Manufacturer's one year Warranty.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Components: Overhung impeller, close coupled, single stage, volute style, end suction submersible sewage pump.

B. Design requirements:
   1. Pump performance characteristics:
      a. Flow and Head 20 gpm at 15 ft head.
      b. Power 120/1/60 manufacturer's Preferred Operating Range (POR).
   3. Suitable for pumping storm water runoff.
   4. Quantity: 1
   5. Location: Truck Scale Pit

2.02 GENERAL USE SUMP PUMP, TYPE 1

A. Manufacturers: One of the following or equal:
   1. Barnes. (Crane Pumps & Systems), SE series.
   2. ITT Goulds Pumps, WS series.
   3. Hydromatic, SKHS series.

B. Materials:
   2. Stainless Steel: ASTM A276 or equal.

C. Pump casing:
   1. Material: Cast iron.
   2. Design Working Pressure: 1.5 times the shut off pressure.
   3. Provide support legs on sump bottom and clearance for suction entrance.
   4. The discharge connection shall be a 2 or 3-inch NPT vertical connection.

D. Impellers:
   1. Material: Cast iron.
   2. 2-vane; maximum enclosed; non-clogging; with pump-out vanes on backside; dynamically balanced; close coupled to motors.
   3. Method of securing to shafts: Threaded lock nut or similar connection.

E. Pump shafts:

F. Bearings:
   1. Upper bearing: Single row; oil lubricated.
2. Lower bearing: Single row; oil lubricated.

G. Shaft seal:
   1. Single mechanical seal.
   2. Materials:
      a. Silicon carbide versus silicon carbide seal faces.
      b. Carbon versus ceramic seal faces.
   3. Elastomer and hardware: Buna-N and 300 series stainless steel.

H. Finishes:
   1. Pump manufacturer to factory prime and coat pump/motor and discharge elbow.
   2. Contractor to provide touch-up field coatings, per manufacturer's requirements.

2.03 DRIVERS

A. Motors:
   1. NEMA B design.
   2. air filled submersible motor.
   3. Insulation:
      a. Under 1.5 horsepower: Class F.
   4. Power: 1 phase, 120 volts.
   5. 1.15 service factor.
   6. Type:
      a. Capable of continuously running with pump unit dry or unsubmerged at ambient temperature rating without damaging motor.
   7. Cable:
      a. Minimum length sump depth to the VCP, plus 15 feet, armored, waterproof cable securely attached to motors with watertight fittings. Provide minimum number 14 AWG cord.

2.04 ACCESSORIES:

A. Check Valve: Apollo 62-100 Series 2 in. Stainless Steel FNPT Check Valve or approved equal.

B. Ball Valve: Apollo 76F Series, 2-inch, Stainless Steel, FNPT ball valve or approved equal.

C. Pressure gauge and gauge cock:
   1. Pressure gauge: Ashcroft Series 1008SL02L15#
   2. Gauge isolation: Apollo 76F Series, 2-inch, Stainless Steel, FNPT ball valve or approved equal.

D. Discharge Piping:
   1. 2-inch HDPE SDR 17
   2. 100 LF field routed where indicated by Engineer
   3. Pressure tested to 30 psig.
   4. Fittings: 10 90 degree elbows, Threaded.

E. Discharge Piping Supports (above grade)
   1. Unistrut - 316 Stainless steel with pipe clamp.
2.05 INSTRUMENTATION

A. Level sensors:
   1. Type: Ball float.
   2. Cable Length: The length of the cable shall be equal to sump depth to the VCP plus 5 feet.

2.06 PACKAGE CONTROL SYSTEM

A. General:
   1. This Section summarizes key control system components for vendor control panels (VCP):
      a. Referenced sections can be obtained from the Contractor for complete control system requirements.
   2. Provide instruments and other components performing similar functions of the same type, model, or class, and from one manufacturer:
      a. Coordinate with Contractor to align make and model with Contractor-furnished equipment.
   3. VCP shall be completely, prewired, and factory tested for proper operation prior to shipment.
   4. Provide necessary control hardware, software, and components as required for a fully functional and operational installation.

B. Panels, enclosures, and panel components:
   1. Manufacturers: One of the following or equal:
      a. nVent/Hoffman.
      b. Saginaw Control & Engineering.
   2. Provide components and equipment with UL 508 listing.
   3. Provide control panels with UL 508A labeled.
   4. Provide fuses for equipment that is not UL listed or recognized.
   5. Provide control panel power circuits:
      a. Design devices and instruments to fail in a safe condition.
   6. Accept single 120 VAC, 1-phase power source:
      a. Terminate incoming power feed on main circuit:
         1) Properly rated for the available fault current.
   7. Panel shall be rated as follows, unless otherwise specified:
      a. Outdoor panels: NEMA 4X, Type 316 stainless steel.
   8. Provide each control panel door with a continuous steel hinge, 3-point latching mechanism and locking handle with rollers on the ends of the latch rods:
      a. Connect latch rods to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
   9. Perform and submit thermal management calculations for each control panel:
      a. Provide heating, cooling, and dehumidifying devices to maintain instrumentation and control devices within their rated operational temperature range.
   10. Pad lockable flange mounted disconnect switch to disconnect power from panel:
       a. Interlock with the panel door.
11. Provide nonmetallic ducts for routing and organization of conductors and cables:
   a. Provide separate ducts for signal and low voltage wiring from power and 120 VAC control wiring.
12. Provide 120 VAC:
   a. Alarm contacts.
13. Provide GFCI duplex 120 VAC convenience receptacle.
14. Factory-assemble and wire the control panel such that field wiring only requires connections to terminals.
15. Provide 316 Stainless Steel supports mounted to concrete pad as indicated on the drawings and specified herein.

2.07 CONTROL REQUIREMENTS:

A. Pilot Devices:
   1. Controls:
      a. HAND-OFF-AUTO selector switch.
      b. START pushbutton for each pump.
      c. STOP pushbutton for each pump.
      b. Momentary LOW-LEVEL OVERRIDE pushbutton.
      c. Alarm silence pushbutton.
   2. Lights:
      a. Status:
         1) Running for each pump.
         2) Stopped for each pump.
      b. Alarms:
         1) Power.
         2) Fault for each pump.
         3) High-high level.
   3. Horns with beacons:
      a. Alarms:
         1) Power.
         2) Fault.
         3) High-high level.

B. Monitoring and control:
   1. Dry contact rating: 120 VAC @ 10 A.VCP Outputs:
      a. Status:
         1) Running for each pump.
      b. Alarms:
         1) Fault for each pump.
         2) High-high level.

C. Hardwired control functions:
   1. HAND:
      a. The pump shall run when the START pushbutton is pressed.
      b. The pump shall stop when the STOP pushbutton is pressed.
      c. The low level switch shall stop the pump.
      d. The low level switch shall be overridden by the momentary LOW-LEVEL OVERRIDE pushbutton.
2. OFF: Pump shall stop operation:
   a. Placing the hand switch in the OFF position shall reset all alarm conditions.
3. AUTO: The pump shall operate automatically in response to level switch signals:
   a. The pump shall start when the rising water level in the sump causes the high level switch to activate.
   b. The pump shall stop when the falling water level in the sump causes the low level switch to activate.
   c. A high-high level shall activate the high-high level alarm.

B. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

A. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 1-day minimum.
   3. Training:
      a. Maintenance: 4 hours per session, 2 sessions.

3.02 PIPING INSTALLATION

A. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.

B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
   1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
   2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
   3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
   4. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

C. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
D. Core drilled openings:
1. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Engineer.
2. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.
3. Remove dust and debris from hole using compressed air.

E. Exposed piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings:
   a. Install piping runs plumb and level, unless otherwise indicated on the Drawings.
      1) Slope plumbing drain piping with a minimum of 1/4-inch per foot downward in the direction of flow.
2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
3. Support piping: provide Preformed Channel Pipe Support System,
   a. Do not transfer pipe loads and strain to equipment.
4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
5. Assemble piping without distortion or stresses caused by misalignment:
   a. Match and properly orient flanges, unions, flexible couplings, and other connections.
   b. Do not subject piping to bending or other undue stresses when fitting piping.
   c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
   d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
   e. Alter piping assembly to fit when proper fit is not obtained.
   f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

F. Buried piping:
1. Bury piping with minimum 3-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench.
   a. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying piping:
   a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
   b. Place piping with top or bottom markings with markings in proper position.
   c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
   d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
3.03 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method.

B. General:
   1. Test pressures shall be 20 psig for sump pump discharge piping.
   2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
   3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
   4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible leaks test:
   1. Subject piping under test to specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
   4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Pressure test piping after completion of visible leaks test.
   2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours, and no damage to piping and appurtenances has occurred.
      b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

END OF SECTION
SECTION 133423 - FABRICATED GUARD HOUSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes one fabricated steel guard house, to be delivered and installed at the A.B. Jewell Water Treatment Plant. The guard house must be identical to others installed at various City of Tulsa locations identified below:
   - City of Tulsa West Yard, 440 W. 23rd Street, Tulsa, OK 74107
   - City of Tulsa East Yard, 5605 S. Garnett Road, Tulsa, OK 74146
   - City of Tulsa UGC, 4235 N. 93rd E. Ave., Tulsa, OK 74117
   - City of Tulsa, 4502 South Galvaston, Tulsa, OK 74107.

1.2 RELATED WORK

A. Work by Owner:
   1. Foundation: Owner will furnish and install concrete foundation for guard house.
   2. Bollards: Owner will furnish and install steel pipe bollards.
   3. Utilities: Owner will furnish and install electrical power, data, and phone through concrete pad for final connection to guard house system. Coordinate location of utility access with Owner.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for guard house.

B. Shop Drawings: For guard house, include plans, elevations, sections, details, accessories, and fastening and anchorage details, including mechanical fasteners.

C. Heat Load Calculations: Provide heat load/(heat loss) calculations for review.

D. Samples: For each type of exposed finish in manufacturer's standard sizes. Include samples of wall panels and accessories to verify finish selection. Submit glass samples for each type of glass product, 12-inches square, for final selection.

E. Closeout Submittals: Submit maintenance data and manuals for guard house.

1.4 COORDINATION

A. Concrete Pad and Utilities: Concrete pad and utilities will be furnished by City of Tulsa. Coordinate installation of guard house with City.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair, finish, or replace guard house should materials or workmanship fail within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.
   2. Warranty Period for Finishes: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Guard house shall be rigid-frame, all steel construction designed to withstand loads and stresses within limits and under conditions as required by the following: 2009 International Building Code.
   5. Construction Type: VB
   6. Use Group Classification: M
   7. Floor Live Load: 100 PSF (1,000 LB Concentrated Load)
   8. Roof Live Load: 50 PSF
   9. Wind Load: 36.9 PSF
      a. Wind Speed: 150 MPH
      b. Exposure: C
      c. Wind Importance Factor: 1.0
   10. Seismic Design Category: B
   12. Building Occupant Load: 2

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

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

D. Safety Glazing: Provide permanently marked certification label of SGCC or manufacturer indicating manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

2.2 FABRICATED STEEL GUARD HOUSE

A. General: Fabricate guard house from an integrated set of mutually dependent components to form a completed assembly, ready for installation on project site. Building Style: As indicated on Drawings.

B. Manufacturers: Subject to compliance with requirements, provide products as follows.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide guard house by Ventaire, Inc. or comparable product by an approved substitute manufacturer. Ventaire, Inc.
      909 N. Wheeling Ave.
      Tulsa, OK 74110
      Phone: (918)622-1191
      Contact: Jeff Weaver, President

   2. Substitutions: Subject to compliance with specified requirements, products by one of the following manufacturers may be substituted for that specified. No other substitutions will be considered.
      a. AustinMohawk and Company, Inc.
      b. B.I.G. Enterprises, Inc.
      c. Delta Scientific Corporation.
      d. Keystone Structures, Inc.
C. Structural Framework: Fabricated from 3 x 2 x 3/16-inch steel structural or mechanical tubing. Connect framework by welding, rigid frame construction.

D. Materials: Structural steel components of guard houses shall be designed, fabricated and erected in accordance with the latest AISC specifications and cold-formed steel components shall conform to the latest AISI specifications.
   1. Wide Flange Sections: ASTM A992 or A572 Grade 50 (Fy = 50 KSI)
   2. Steel Plates, Shapes, Angles, Channels, and Bars: ASTM A36 (Fy = 36 KSI)
   3. Hollow Structural Sections (Tube): ASTM A500, Grade B (Fy = 46 KSI)
   5. Pipe Sections: ASTM A53, Grade B (Fy = 35 KSI)
   6. Roof Deck: ASTM A653, Grade 50 (Fy = 50 KSI), galvanized (G60) with baked enamel finish.
   7. Wall Panels: ASTM ASTM A653, Grade 50 (Fy = 50 KSI), galvanized (G60) with baked enamel finish.
   8. Ceiling Panels: ASTM ASTM A653, Grade 50 (Fy = 50 KSI), galvanized (G60) with baked enamel finish.
   9. Steel Outriggers: ASTM ASTM A653, Grade 40 (Fy = 40 KSI), galvanized (G90) per ASTM 924.
   10. Structural Bolts: ASTM A325.
   11. Anchor Bolts: ASTM F 1554, Grade 36, ASTM A36; or ASTM A307 material (Fy = 36 KSI).
   15. Structural Steel: Shop coated with red-oxide rust inhibitive primer.
   16. Structural steel and cold formed steel sections shall conform to ASTM E84 fire rating Class "A".
       Flame Spread = 0 - 25. Smoke Developed = 0 - 450.
   17. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized according to ASTM A 123/A 123M. (Base only.)
   18. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
      b. Extruded Shapes: ASTM B 221.
   19. Stainless-Steel Sheet: ASTM A 666, Type 304.

E. Base/Floor Assembly: 8-inch high assembly consisting of perimeter frame, 8-inch galvanized-steel structural steel channels welded to structural framework of booth, 3-1/2-inch thick concrete floor, with 4" extruded polystyrene insulation (R=20). Include anchor clips fabricated from 1/4-inch-thick (min) galvanized-steel plate, predrilled and welded to exterior of integral floor frame.
   1. Finished Floor: Vinyl Composition Tile over concrete.

F. Anchorage: Post-installed anchors fabricated from non-ferrous or corrosion-resistant materials, with allowable load or strength design greater than or equal to the design load as determined by testing conducted by a qualified testing agency.

G. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 20 GA nominal-thickness, galvanized-steel sheet; with EIFS finish coating. Interior face panel fabricated from 20 GA nominal-thickness, galvanized-steel sheet, white embossed; with 3-1/2-inch-thick, semi-rigid fiberglass insulation (R=11 or greater) in cavity between exterior and interior face panels.
   1. Insulation Fire Resistance: Flame Spread Index 25. Smoke Developed Index 50.

H. Metal Roof Panels: Standing Seam Metal Roof System. Snap-Together System, 12" wide panels, 1-3/4" ribs, formed with standing seam major ribs and intermediate stiffening profile symmetrically spaced between major ribs, designed to be installed by lapping side edges of adjacent panels and mechanically attaching panel to supports using concealed fasteners in side laps.
1. Type and Manufacturer: Lokseam by MBCI, Oklahoma City, OK.

2. Material: Zinc-coated (galvanized) steel sheet, 0.034-inch nominal thickness,
   a. Exterior Finish: Three-coat fluoropolymer. (Kynar)
   b. Color: As selected by Owner from manufacturer's full range.

3. Major-Rib Spacing: 12 inches o.c.
4. Panel Height: 1.75 inches.
5. Roof Design: Hip roof with concealed fasteners, sloped to integral gutters at guard house eaves, entire perimeter.
6. Canopy Fascia: Fabricated from 0.079-inch nominal-thickness, galvanized-steel sheet, of custom design indicated on Drawings.
   a. Height: 8 inches.
   b. Overhang: As indicated on Drawings, beyond face of walls below.

I. Metal Soffit Panels: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weather-tight installation.
   1. Finish: Match finish and color of metal roof panels.

J. Doors: Swinging door on back of guard house.
   1. Swinging Door: 1-3/4 inches thick; insulated tubular-frame design fabricated from 18 ga. galvanized steel, with top half of door glazed. Equip door with lock, continuous gear hinge, closer, full weather stripping and threshold.
   3. Glazing: Fixed unit with tinted insulating glass as specified below. Glazing gaskets per manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks and shims or spacers.
   4. Hardware:
      a. Hinges: Continuous gear hinges, manufacturer's standard with stainless -steel bearings between knuckles, fabricated to full height of door and frame.
      b. Lock: Corbin-Russwin Lever Handle Lockset, capable of being master keyed, with interchangeable cores. BHMA A156.5, Grade 1. Coordinate security function with City of Tulsa Security.
      c. Closer: LCN 4040, clear finish, push-side mount. BHMA A156.4, Grade 1. Cush-N-Stop, ARM, (4040-3077N3)
      d. Silencers: BHMA A156.16, Grade 1.
      e. Threshold: Pemco #2005AV BHMA A156.21.
      f. Drip Rail: #346Cx40, by Pemco.
      g. Weatherstripping: #303AV
      h. Latchguard: Ives.
      i. Keying: Master key system. Permanently inscribe each key with a visual notation "DO NOT DUPLICATE". Coordinate with City of Tulsa Security.

K. Windows: Extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads, glazed with insulating glass as specified below.
   1. Performance
      a. Water Penetration under Static Pressure: ASTM E331. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
      b. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature change of, 120 degrees F, ambient; 180 degrees F, material surfaces.
2. Frame Material and Finish: Alloy and temper recommended by manufacturer for type of use. Finish to be manufacturer's standard clear anodic, AAMA 611, AA-M12C22A31, Class II, 0.010 or thicker.
3. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
4. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.
5. Fixed Glazing: Retained mechanically with gaskets on four sides.
7. Corner Shape: Square.
8. Fabrication Method: Shop fabricated system.

L. Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 6.0-mm thick float glass as specified below with 1/2-inch dehydrated air space, with a total overall unit thickness of one inch and with manufacturer's standard dual seal.
1. Solar Heat Gain Coefficient: SHGC: :: 0.35
2. Overall Unit Thickness: 1 inch.
3. Flat Glass (general): ASTM C1036, Type I, Class 1, Quality q3, Y.-inch(6-mm) thick.
4. Tempered Flat Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality q3; Y.-inch(6.0 mm) thick.
5. Outdoor Lite: Tinted float, fully tempered, vision glass with low-e sputter coating on Number Two surface. Color: Pilkington "Optifloat" Grey. Final color selection to be approved by Owner prior to fabrication.
7. Interspace Content: Dehydrated Air.
8. Glazing Sealants: As recommended by manufacturer.

M. Ceiling: Interior 24" x 24" lay-in Ceiling Panels, with fiberglass insulation above ceiling. Ceiling Height: 8'-0" (min), see drawings.

N. Heating/Cooling Unit: Mini-Split type system. Wall-mounted, thermostatically controlled, 110-V, 2500W electric heater with fan-forced operation and with capacity of not less than 2,500 Btu/h and controlled air conditioner with cooling capacity of not less than 12,000 Btu/h. Enclose in enamelled-steel cabinet and mount as indicated on Drawings.

O. Baseboard Heater: 2500 watt baseboard heater, mounted beneath desk.

P. Electrical Power Service: 100-A, 120/240-V ac, single-phase, three-wire service with 8-16 circuit-breaker panel; located under sliding window as shown on drawings. Run copper wiring in 1/2-inch EMT conduit.
1. Provide one dual 120-V ground-fault circuit interrupter (GFCI) power receptacle(s) on front exterior of building, in weatherproof box, 12" AFF.
2. Provide two quad power receptacles (four total) on front and rear interior walls of guard house, 12" AFF.
3. Electrical Panel: Mount on interior of building, underneath working desk (front). Electrical panel shall accommodate the following:
   a. 1 circuit for interior outlets.
   b. 1 circuit for interior lighting.
   c. 1 circuit for exterior outlets.
   d. 1 circuit for exterior lighting.
e. 1208/230 circuit for HVAC system.

f. 1 electric radiant heating.

g. 1 circuit for gate openers.

h. 3 open circuits.

4. Final connection of guard house breaker to utilities, by City of Tulsa.

Q. Lighting Fixtures: Provide single-pole switch mounted adjacent to door to control lighting fixture.
   1. Interior Lights: 24x24 troffer lighting fixture(s), with acrylic lens and two 40-W T5 lamps in each fixture.
   2. Red Light: Provide one incandescent light (Red) over front desk with separate wall switch.
   3. Exterior Lights: Two exterior flood lights, with manual up and down adjustment, one on either side of building mounted over sliding windows.
   4. Exterior Recessed Lighting: Provide eight LED recessed can soffit lights, 100W each, capable of shining away from side of building to illuminate area surrounding building. To be on automatic timer to come on at dusk and off at dawn.

R. Work Counters: Full width of control booth, reinforced; with 16-inch-wide storage drawer below each counter and 3" diameter grommet access openings for electrical cords at each rear corner of counter.
   1. Material: 3/4-inch-thick particleboard with plastic-laminate finish.
   2. Depth: 22 inches.
   3. Plastic Laminate: NEMA LD 3, HGS or HGL grade.

2.3 FABRICATION

A. Factory fabricate guard house completely.

B. Factory preglaze windows and doors.

C. Factory prewire guard house, ready for connection to services (power, data, telephone) at project site.

D. Fabricate guard house with forklift pockets in base of booth.

PART 3 - EXECUTION

3.1 DELIVERY

A. Deliver one guard house to the following location:

   A. B. Jewell Water Treatment Plant
   18707 E. 21st Street
   Tulsa, OK 74134

3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including concrete bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the work.

B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before control booth installation and final connection to utilities.
C. Notify Owner of conditions detrimental to performance of the work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install guard house on owner-furnished concrete pad.

B. Install guard house according to manufacturer's written instructions.

C. Set guard house plumb, level, and aligned. Level baseplates true to plane with full bearing on concrete base.

D. Fasten guard house securely to concrete base with anchorage indicated.

E. Connect to electrical power service, data, and telephone systems.

F. Perform startup checks of heating and cooling units according to manufacturer's written instructions.

3.4 ADJUSTING & TESTING

A. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

C. After completing installation, inspect exposed finishes and repair damaged finishes.

D. Field Quality-Control Testing: Perform water-spray test on entire perimeter of guard house for water penetration. Guard house should perform with no evidence of water penetration.

END OF SECTION 133423
METAL ROOF OVER STEEL FRAMING

20 GA GUTTER (15' ALUM CUTOFF)

ALUM CORNER CLADDING TO MATCH STOREFRONT SYSTEM

1" INSUL GLASS IN 2" X 4 1/2" ALUM STOREFRONT FRAMES

ELS'S (D RVIT) TEXTURED COATING OVER METAL SUBSTRATE

GALV STEEL CHANNEL FRAME

CONC PAD

BLDG ELEVATION - FRONT

1/2" = 1'-0"
**Building Section**

- **Metal Roof Over Steel Framing**
- **Recessed Can Lt**
- **30 Ga Gutter + Soffit To Match Roof**
- **2" Fiberglass Batt Insul**
- **3/4" Fiberglass Insul**
- **2x2 Acoustic Lay-In Panel Ceiling**
- **1" Insul Glass In 3/4x4 1/2' Alum Soffit Frame**
- **4" Ruber Sedge**
- **Vinyl Tile Flr**
- **3/4" Conc Floor On 22 Ga Galv Steel Deck**
- **Baseboard HTR**
- **Concrete Pad By Owner**
- **4" Expanded Polystyrene Insulation (R=20)**

**Notes:**

- **8" Steel (GALV) Channel Frame**

**Scale:** 1/2" = 1'-0"