

SDSTA SPECIFICATIONS
for
Replace Power Cable to East Switchyard

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Description

This project will replace the buried section of medium voltage feeder cable that runs through the Yates Tramway to the East Switchyard. The new cable will be installed following a new route that will include overhead lines starting near the Yates Tramway Portal location going up to the Yates Complex Yard where it will transition to a buried duct bank to the East Switchyard.

B. Location

The work is located at the Yates Complex of the Sanford Underground Research Facility, approximately as indicated: The take-off point for the new cable will be outside the Yates Tramway Portal and proceed to the East Switchyard.

1.2 OCCUPANCY OF PREMISES

A. The location of work will be predominantly around the Yates Complex Yard which also supports ongoing surface and underground operations. Signage and other related notifications will be posted in a prominent location in the work areas.

B. Before work is started, arrange with the Project Manager a sequence of procedure, means of access, space for storage of materials and equipment, and use of roadways, storage areas, entryways and/or approaches.

1.3 EXISTING WORK

A. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Project Manager. At the completion of operations, existing work must be in a condition equal to or better than that which existed before new work started.

1.4 LOCATION OF EXISTING UTILITIES

A. Obtain digging permits prior to start of excavation and comply with Facility requirements for locating and marking underground utilities. Contact local utility locating service a minimum of 72 hours prior to excavating, to mark utilities, and within sufficient time required if work occurs on a Monday or after a Holiday. Verify existing utility locations indicated on contract drawings, within area of work.

1.5 NOTIFICATION PRIOR TO EXCAVATION WORK IN YATES COMPLEX

A. Notify the Project Manager at least 48 hours up to 5 days depending on level of excavation required prior to starting excavation work.

B. The Yates Complex work area is an important part of SURF/SDSTA working operation. The Yates serves as an active entrance into/out of the underground facilities. SDSTA UG operations and maintenance crews are located within the Yates Complex along with the warehouse facility for the entire operation. Delivery trucks from passenger van size up to 53' tractor-trailer rigs, require access to drop off supplies on a Monday thru Friday, 7:00 AM – 4:00 PM schedule.

- C. Daily activities at the Yates need to occur without being adversely impacted. Coordination of duct bank installation activities will be required to ensure that normal SURF/SDSTA operations can continue throughout the duration of the project. Planning, scheduling, and regular communications with SDSTA are expected during trenching, duct installation, and trench backfilling work. The length of open trench allowed after daily work will be kept to a minimum reasonable amount, dependent upon work location.

END OF SECTION

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 PROGRESS AND COMPLETION PICTURES

- A. Photographically document site conditions prior to start of construction operations.
- B. Obtain weekly digital photographs showing the sequence and progress of work to clearly capture the work performed during that period, in particular areas that will be covered as part of the scope of work.
- C. Submit project photographs with the monthly invoice.
- D. Photographs provided are for unrestricted use by the SDSTA.

1.2 SUPERVISION

- A. Minimum Requirements

Have at least one qualified superintendent, or competent alternate, capable of reading, writing, and conversing fluently in the English language, on the jobsite at all times during the performance of contract work. In addition, if a Quality Control (QC) representative is required on the contract, then that individual must also have fluent English communication skills.
- B. Superintendent Qualifications
 1. The project superintendent must have a minimum of 10 years' experience in construction with at least two of those years as a superintendent on projects similar in size and complexity.
 2. The individual must have experience in the areas of hazard identification and safety compliance.
 3. The individual must be capable of interpreting a critical path schedule and construction drawings.
 4. The qualification requirements for the alternate superintendent are the same as for the project superintendent.
 5. The Contracting Officer may request proof of the superintendent's qualifications at any point in the project if the performance of the superintendent is in question.
 6. For routine projects where the superintendent is permitted to also serve as the Quality Control (QC) Manager as established in Section 01 45 00.10 QUALITY CONTROL FOR CONSTRUCTION, the superintendent must have qualifications in accordance with that section.
- C. Superintendent Duties
 1. The project superintendent is primarily responsible for managing and coordinating day-to-day production and schedule adherence on the project.
 2. The superintendent is required to attend status meetings and quality control meetings if applicable.
 3. The superintendent or qualified alternate must always be on-site during the performance of this contract until the work is completed and accepted.
- D. Non-Compliance Actions

1. The Project Superintendent is subject to removal by the Contracting Officer for non-compliance with requirements specified in the contract and for failure to manage the project to insure timely completion.
2. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders is acceptable as the subject of claim for extension of time for excess costs or damages by the Contractor.

1.3 PRECONSTRUCTION CONFERENCE

- A. After award of the contract but prior to commencement of any work at the site, meet with the Project Manager to discuss and develop a mutual understanding relative to the administration of the quality control, safety program, preparation of the schedule of prices, shop drawings, and other submittals, scheduling programming, and execution of the work. Major subcontractors who will engage in the work must also attend.

END OF SECTION

SECTION 01 32 00
PROJECT CONSTRUCTION PROGRESS SCHEDULES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Construction Schedule
- B. Monthly Schedule Updates

1.2 ACCEPTANCE

- A. Prior to the start of work, prepare and submit to the Project Manager for acceptance a Baseline Construction Schedule.
- B. The acceptance of a Baseline Construction Schedule is a condition precedent to:
 - 1. The Contractor starting work on the demolition or construction stage(s) of the contract.
 - 2. Processing Contractor's invoice(s) for construction activities.
 - 3. Review of any schedule updates.
- C. Submittal of the Baseline Schedule, and subsequent schedule updates, is understood to be the Contractor's certification that the submitted schedule meets all the requirements of the Contract Documents, represents the Contractor's plan on how the work will be accomplished, and accurately reflects the work that has been accomplished and how it was sequenced.

1.3 SCHEDULE FORMAT

- A. The Baseline Schedule must be in the form of a Gantt Chart Schedule.
 - 1. The Gantt Chart must list the dates and durations of key milestones or major features of work.
 - 2. The Gantt Chart must, at a minimum, show work activities, major material/equipment delivery, on-site construction, key inspections, and closeout activities.
 - 3. The Gantt Chart must include a graphical representation of the Baseline Schedule.
 - 4. The chart must be time scaled and generated using an electronic spreadsheet program.
- B. Schedule Submittals and Procedures
 - 1. Submit Gantt Chart Schedules and updates in hard copy and on electronic media that is acceptable to the Project Manager.

1.4 SCHEDULE UPDATES

- A. The schedule must be kept current, reflecting actual progress and plan for completing the remaining work.
- B. At a minimum, update the Construction Schedule at monthly intervals or when the schedule has been revised.

1.5 CONTRACT MODIFICATION

- A. Submit a schedule analysis with each cost and time proposal for a proposed change. The analysis must illustrate the influence of each change or delay on the Contract Completion Date or milestones.

- B. No time extensions will be granted nor delay damages paid unless a delay occurs which consumes all available Project Float and extends the Projected Finish beyond the Contract Completion Date.
- C. Identify types of time delays as follows:
 - 1. Excusable Delay: Force-Majeure (e.g., unusual weather) - Contractor may receive time extension, but time will not be compensable.
 - 2. Inexcusable Delay: Contractor Responsibility - Contractor will not receive time extension
 - 3. Compensable Delay: SDSTA Responsibility - Contractor may receive compensable time extension.
- D. If a combination of any of the delay types outlined above occurs, it is considered a Concurrent Delay, which will require an analysis of the facts to determine compensability and entitlement to any time extension under the applicable contract clauses.

1.6 WEEKLY PROJECT STATUS MEETING AND 3-WEEK LOOK AHEAD SCHEDULE

- A. Each week during the active construction period, a Weekly Status Meeting will be held.
 - 1. At a minimum, the project superintendent and QC Manager should attend representing the Contractor.
 - 2. Meeting minutes will be taken by the superintendent or other designated representative to capture the discussions.
- B. As part of the process, the Contractor will prepare and issue a 3-Week Look Ahead schedule to provide a more detailed day-to-day plan of upcoming work identified on the Construction Schedule.
 - 1. The 3-Week Look Ahead schedule must identify upcoming outages, closures, etc.
 - 2. The detailed work plans are to be outlined in Gantt chart type schedules, separate from the Construction Schedule, on an electronic spreadsheet program and printed on (8-1/2 by 11 inch) sheets as directed by the Project Manager.
- C. In addition to schedule discussions, the Weekly Status Meeting should discuss status of submittal reviews and approvals, Requests for Information (RFI), outstanding change orders, and other relevant project coordination issues.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 DEFINITIONS

A. Submittal Descriptions (SD)

Submittal requirements in addition to those noted below may be specified in the technical specification sections and drawings.

1. Preconstruction Submittals

Submittals which are required prior to start of construction (work). These submittals are considered Action Submittals (See definition below).

- a. List of Proposed Subcontractors
- b. Construction Progress Schedule
- c. Submittal Register
- d. Schedule of Prices
- e. Health and Safety Plan
- f. Quality Control (QC) Plan
- g. Environmental Protection Plan

2. Shop Drawings

Drawings, diagrams, and schedules specifically prepared to illustrate some portion of the work.

- a. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.
- b. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

3. Product Data

Catalog cutsheets, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems, or equipment for some portion of the work.

- a. Proof that products and materials meet ASTM standards and are listed and approved for the application in which they are being used by a Nationally Recognized Testing Laboratory.
- b. Samples of warranty language when the contract requires extended product warranties.

4. Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

- a. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.
- b. Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

5. Test Reports

Report signed by an authorized official of a certified testing laboratory that a material, product, or system identical to the material, product, or system to be provided has been tested in accord with specified requirements. Unless specified in another section, testing must have been within three years of date of contract award for the project.

- a. Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.
- b. Report which includes the finding of a test made at the job site or on any sample taken from the job site, on a portion of work during or after installation.

6. Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that the product, system, or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

7. Operation and Maintenance Data

Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel, including manufacturer's help and product line documentation necessary to maintain and install equipment. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance, and repair of the item.

- a. This data is intended to be incorporated in an Operations and Maintenance manual or control system.

8. Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

- a. Special requirements necessary to properly close out a construction contract. For example, as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.2 SUBMITTAL CATEGORY

A. Action Submittals:

Written and graphic information and physical samples that require AE's and/or Project Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals:

Written and graphic information and physical samples that do not require AE's and/or Project Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL REGISTER

A. Use of Submittal Register

1. Submit a register of submittals, arranged in chronological order by dates required by construction schedule. For this project, the Contractor is required to establish a project specific account through Submittal Exchange or an approved alternative system for the processing of all submittals, RFI's and other project related information.
2. Register must include submittal line items required by A/E (provided in separate document.)

3. Register must include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates.
4. Register must include additional time required for making corrections or revisions to submittals noted by the A/E and additional time for handling and reviewing submittals required by those corrections.
5. Coordinate the submittal register with the list of subcontracts, the schedule of values, and the Contractor's construction schedule.
6. Initial Submittal – Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
7. Submit revised submittal schedule to reflect changes in the status and timing for submittals.

B. Format.

1. Arrange the following information (at a minimum) in a tabular format: (As applicable)
 - a. Activity or Event Number.
 - b. Transmittal Number
 - c. Specification Section Number and Title
 - d. Submittal category (Action, Informational)
 - e. Description of the Work Covered
 - f. Name of Contractor/Subcontractor
 - g. Scheduled Date for First Submittal
 - h. Scheduled Date for Final Release or Approval.
 - i. Scheduled Date for Purchasing
 - j. Scheduled Date of Fabrication
 - k. Scheduled Date for Installation.

1.4 VARIATIONS

- A. Variations from contract requirements require both A/E and SDSTA approval and will be considered where advantageous to SDSTA.**

B. Considering Variations

1. Discussion with Project Manager and A/E prior to submission will help ensure functional and quality requirements are met and minimize rejections and re-submittals.
2. Specifically point out variations from contract requirements in transmittal letters. Failure to point out deviations may result in the rejection and removal of such work at no additional cost to the SDSTA

C. Proposing Variations

When proposing variation, deliver written request to the Project Manager, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to SDSTA. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

D. Warranting that Variations are Compatible

When delivering a variation for approval, Contractor, including its Designer(s) of Record (if applicable), warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

E. Review Schedule Extension

In addition to normal submittal review period, a period of 10 working days will be allowed for consideration by the A/E and SDSTA of submittals with variations.

1.5 SCHEDULING

- A. Schedule and submit concurrently submittals covering component items forming a system or items that are interrelated. Include certifications to be submitted with the pertinent drawings at the same time. No delay damages or time extensions will be allowed for time lost in late submittals.
 - 1. Coordinate scheduling, sequencing, preparation, and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential resubmittal of requirements.
 - 2. Re-submit register and annotate monthly by the Contractor with actual submission and approval dates. When all items on the register have been fully approved, no further re-submittal is required.
 - 3. Carefully control procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

- B. Review Notations

Submittals will be returned to the Contractor with the following notations:

- 1. Submittals marked "Accepted" authorize the Contractor to proceed with the work covered.
 - 2. Submittals marked "Accepted as Noted" or "Accepted as Noted, Resubmittal not Required," authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections.
 - 3. Submittals marked "Revise and Resubmit," indicate noncompliance with the contract requirements or design concept, or that submittal is incomplete. Resubmit with appropriate changes. No work shall proceed for this item until resubmittal is approved.
 - 4. Submittals marked "Not Reviewed" will indicate submittal has been previously reviewed and accepted, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "Not Reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.

1.6 REJECTED SUBMITTALS

- A. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the contract is to be given to the Contracting Officer. Contractor is responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the SDSTA requiring rejection and removal of such work at the Contractor's expense.
- B. If changes are necessary to submittals, make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.7 ACCEPTED SUBMITTALS

- A. The acceptance of submittals is not to be construed as a complete check and indicates only that acceptance will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work.

- B. After submittals have been accepted, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.8 APPROVED SAMPLES

- A. Approval of a sample is only for the characteristics or use named in such approval and is not construed to change or modify any contract requirements. Before submitting samples, the Contractor is to assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.
- B. Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract.
- C. Samples of various materials or equipment delivered on the site or in place may be taken by the SDSTA for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor to replace such materials or equipment to meet contract requirements.
- D. Approval of the Contractor's samples does not relieve the Contractor of his responsibilities under the contract.

END OF SECTION

SECTION 01 45 00.10
QUALITY CONTROL FOR CONSTRUCTION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
 - 1. SD-01 Preconstruction Submittals
 - 2. QC Plan – Submit a QC Plan within 30 calendar days after receipt of Notice of Award and prior to mobilization.

1.2 INFORMATION REQUIREMENTS

- A. Prior to commencing work on construction, the Contractor can obtain a single copy set of the current report forms from the Project Manager. The report forms will consist of the Contractor DAILY Report, Contractor DAILY Report (Continuation Sheet), Rework Items List, and Testing Plan and Log.
- B. Deliver the following to the Project Manager and the designated SDSTA QA Rep:
 - 1. DAILY Report: By 10:00 AM the next working day after each day that work is performed
 - 2. Field Test Reports: One copy, within one week after the test is performed, attached to the CQC Report
 - 3. QC Certifications: As required by the paragraph entitled "QC Certifications"

1.3 QC PROGRAM REQUIREMENTS

- A. Establish and maintain a QC program as described in this section. The QC program consists of a QC Manager, a QC Plan, a Project Preconstruction Conference, Weekly Status Meeting, submittal review, testing, and QC certifications and documentation necessary to provide materials, equipment, workmanship, fabrication, construction, and operations which comply with the requirements of this contract. The QC program shall cover on-site and off-site work and shall be keyed to the work sequence. No work or testing may be performed unless the QC Manager is on the work site.
- B. Preliminary Work Authorized Prior to Acceptance
The only work that is authorized to proceed prior to the acceptance of the QC Plan is mobilization of storage and office trailers, temporary utilities, and surveying.
- C. Acceptance
Acceptance of the QC Plan is required prior to the start of construction. The SDSTA reserves the right to require changes in the QC Plan and operations as necessary, including removal of personnel, to ensure the specified quality of work.
- D. Notification of Changes
Notify the Contracting Officer, in writing, of any proposed change, including changes in the QC organization personnel, a minimum of seven calendar days prior to a proposed change. Proposed changes shall be subject to the acceptance by the Contracting Officer.

1.4 QC ORGANIZATION

- A. Minimum Requirements

Provide a QC Manager at the work site to implement and manage the QC program. In addition to implementing and managing the QC program, the QC Manager may perform the duties of project superintendent.

B. QC Manager Qualifications

1. An individual with a minimum of 5 years combined experience as a superintendent, inspector, QC Manager, project manager, or construction manager on similar size and type construction contracts which included the major trades that are part of this contract.
2. The individual must be familiar with and have experience in the areas of hazard identification and safety compliance.

C. QC Manager Duties

1. The QC Manager is required to attend the Project Preconstruction Meeting.
2. The QC Manager is required conduct the QC meetings (if separate from the Weekly Status Meeting), perform submittal review, ensure testing is performed and provide QC certifications and documentation required in this contract.
3. The QC Manager is responsible for managing and coordinating documentation performed by others.
4. The QC Manager is responsible for inspecting and reporting the status of the Storm Water Pollution Prevention Plan described in section 01 50 00.

D. Alternate QC Manager Duties and Qualifications

1. Designate an alternate for the QC Manager to serve in the event of the designated QC Manager's absence. The period of absence may not exceed two weeks at one time, and not more than 30 workdays during a calendar year.
2. The qualification requirements for the Alternate QC Manager shall be the same as for the QC Manager.

1.5 QC PLAN

A. Requirements

Provide, for acceptance by the Contracting Officer, a QC Plan that covers both on-site and off-site work and includes the following with a table of contents listing the major sections identified with tabs.

- I. QC ORGANIZATION: A chart showing the QC organizational structure and its relationship to the production side of the organization.
- II. NAMES AND QUALIFICATIONS: In resume format, for each person in the QC organization.
- III. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL: Of each person in the QC organization.
- IV. OUTSIDE ORGANIZATIONS: A listing of outside organizations such as architectural and consulting engineering firms that will be employed by the Contractor and a description of the services these firms will provide.
- V. APPOINTMENT LETTERS: Letters signed by an officer of the firm appointing the QC Manager and Alternate QC Manager and stating that they are responsible for managing and implementing the QC program as described in this contract. Include in this letter the QC Manager's authority to direct the removal and replacement of non-conforming work.

- VI. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER: Procedures for reviewing and managing submittals. Provide the name(s) of the person(s) in the QC organization authorized to review and certify submittals prior to approval.
- VII. TESTING LABORATORY INFORMATION: Testing laboratory information required by the paragraphs "Accredited Laboratories" or "Testing Laboratory Requirements", as applicable.
- VIII. TESTING PLAN AND LOG: A Testing Plan and Log that includes the tests required, referenced by the specification paragraph number requiring the test, the frequency, and the person responsible for each test.
- IX. PROCEDURES TO COMPLETE REWORK ITEMS: Procedures to identify, record, track, and complete rework items.
- X. DOCUMENTATION PROCEDURES: Use SDSTA formats or agreed upon formats with SDSTA QA Manager and Contractor.
- XI. PROCEDURES FOR COMPLETION INSPECTION: See the paragraph entitled "COMPLETION INSPECTIONS".

1.6 PROJECT PRECONSTRUCTION CONFERENCE

- A. During the Preconstruction Conference and prior to the start of construction, discuss the QC program required by this contract. The purpose is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, and the coordination of the Contractor's management, production, and the QC personnel.
 - 1. At the meeting, the Contractor will be required to explain how quality control will be implemented for key features of work.
 - 2. Contractor's personnel required to attend shall include the QC Manager, project manager, and superintendent.
 - 3. Minutes of the meeting will be prepared by the QC Manager and signed by both the Contractor and the Project Manager. The Contractor shall provide a copy of the signed minutes to all attendees.

1.7 TESTING

- A. Except as stated otherwise in the specification sections, perform sampling and testing required under this contract.
- B. Accreditation Requirements

Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate standards listed in the technical sections of the specifications.
- C. Test Results
 - 1. Cite applicable Contract requirements, tests or analytical procedures used.
 - 2. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify the Contracting Officer immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable.
 - 3. Test results shall be signed by a testing laboratory representative authorized to sign certified test reports.

4. Furnish the signed reports, certifications, and other documentation to the Project Manager.

1.8 QC CERTIFICATIONS

A. Invoice Certification

Furnish a certificate with each payment request, signed by the QC Manager, attesting that as-built drawings are current and attesting that the work for which payment is requested, including stored material, is in compliance with contract requirements.

B. Completion Certification

Upon completion of work under this contract, the QC Manager shall furnish a certificate attesting that "the work has been completed, inspected, tested and is in compliance with the contract."

1.9 COMPLETION INSPECTIONS

A. Punch-Out Inspection

Near the completion of all work or stated elsewhere in the specifications, the QC Manager shall conduct an inspection of the work and develop a punch list of items which do not conform to the approved drawings and specifications.

1. Include in the punch list any remaining items of the "Rework Items List", which were not corrected prior to the Punch-Out inspection.
2. The punch list shall include the estimated date by which the deficiencies will be corrected.
3. A copy of the punch list shall be provided to the Project Manager.
4. The QC Manager or staff shall make follow-on inspections to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the SDSTA that the facility is ready for the SDSTA "Pre-Final Inspection".

B. Pre-Final Inspection

The SDSTA and QC manager will perform this inspection to verify that the facility is complete and ready to be occupied.

1. A SDSTA pre-final punch list may be developed as a result of this inspection.
2. The QC Manager shall ensure that all items on this list are corrected prior to notifying the SDSTA that a "Final" inspection with the customer can be scheduled.
3. Any items noted on the "Pre-Final" inspection shall be corrected in a timely manner and shall be accomplished before the contract completion date for the work or any particular increment thereof if the project is divided into increments by separate completion dates.

C. Final Acceptance Inspection

The QC Manager, the superintendent, or other Contractor management personnel and the Project Manager and SDSTA QA Rep will be in attendance at this inspection. The final acceptance inspection will be formally scheduled based upon results of the "Pre-Final Inspection".

1.10 DOCUMENTATION

A. Maintain current and complete records of on-site and off-site QC program operations and activities.

1. Reports are required for each day work is performed. Account for each calendar day throughout the life of the contract.
2. The superintendent and the QC Manager (if separate) must prepare and sign the Contractor DAILY Report.

3. The reporting of work shall be identified by terminology consistent with the construction schedule. Use the "remarks" section in this report to record pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given, and corrective actions taken, delays encountered and a record of visitors to the work site.

B. As-Built Drawings

The QC Manager is required to review the as-built drawings and ensure they are kept current on a regular basis and marked to show deviations, which have been made from the Contract drawings.

1. Ensure each deviation has been identified with the appropriate modifying documentation, e.g., modification number, RFI number, etc.
2. The QC Manager shall initial each deviation or revision.
3. Upon completion of work, the QC Manager shall submit a certificate attesting to the accuracy of the as-built drawings prior to submission to the SDSTA.

1.11 NOTIFICATION ON NON-COMPLIANCE

- A. The Project Manager or QA Rep will notify the Contractor of any detected non-compliance with the foregoing requirements.
 1. The Contractor shall take immediate corrective action.
 2. If the Contractor fails or refuses to correct the non-compliant work, the Contracting Officer will issue a non-compliance notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification.
 3. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken.
 4. The Contractor shall make no part of the time lost due to such stop orders the subject of claim for extension of time, for excess costs, or damages.

END OF SECTION

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The most recent version of all publications (codes and standards) adopted by the State of South Dakota apply to this contract.
- a. Institute of Electrical and Electronic Engineers (IEEE)
 - b. ANSI C2 – National Electrical Safety Code (NESC)
 - c. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
 - d. NFPA 70 – National Electrical Code
 - e. NFPA 70E – Standard for Electrical Safety in the Workplace
 - f. NFPA 241 – Standard for Safeguarding Construction, Alteration, and Demolition Operations

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
1. Construction Site Plan
 2. Traffic Control Plan
 3. Storm Water Pollution Prevention Plan (SWPPP)

1.3 CONSTRUCTION SITE PLAN

- A. Prior to the start of work, submit a site plan showing the locations and dimensions of temporary facilities.
1. Include layouts and details, equipment, and material storage area (onsite and offsite), and access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation.
 2. Identify any areas which may have to be graveled to prevent the tracking of mud.
 3. Indicate if the use of a supplemental or other staging area is desired.
 4. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

1.4 TEMPORARY TRAFFIC CONTROL

- A. Barricades.
- Erect and maintain temporary barricades to limit public access to hazardous areas.
1. Whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic, barricades will be required.
 2. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.
- B. Fencing
- Provide fencing along the construction site at all open excavations and tunnels to control access by unauthorized people.

1. The safety fencing must be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 1.2 m (48 inches) high and maximum mesh size of 50 mm (2 inches), supported and tightly secured to steel posts located on maximum 3 m (10 foot) centers, constructed at the approved location.
2. Install fencing to be able to restrain a force of at least 114.00 kg (250 pounds) against it.

1.5 STORM WATER POLLUTION PREVENTION PLAN

- A. Prior to the start of work, submit a construction Storm Water Pollution Prevention Plan (SWPPP.)
 1. The SWPPP must contain a site map(s) showing the construction site perimeter, existing and proposed buildings, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the project.
 2. The SWPPP must list Best Management Practices (BMPs) the contractor will use to control erosion from storm water runoff and protect the placement of BMPs.
 3. The SWPPP must include provisions for controlled discharge of contaminated water and the cleanup of hazardous waste.
- B. Weekly SWPPP Inspections
 1. The QC Manager (or designated alternate) must conduct a SWPPP inspection weekly and after every occurrence of a storm event.
 2. Submit a SWPPP inspection report to the Project Manager at the weekly QC meetings (if separate from the Weekly Status Meeting.)

1.6 EMPLOYEE PARKING

- A. Contractor employees will park privately owned vehicles in an area designated by the Project Manager. This area will be within reasonable walking distance of the construction site. Contractor employee parking must not interfere with existing and established parking requirements of the SDSTA installation.

1.7 AVAILABILITY AND USE OF UTILITY SERVICES

- A. Sanitation

Provide and maintain within the construction area minimum field-type sanitary facilities approved by the Project Manager and periodically empty wastes into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Obtain approval from the system owner prior to discharge into any district or commercial sanitary sewer system. Any penalties and/or fines associated with improper discharge will be the responsibility of the Contractor. Coordinate with the Project Manager and follow sanitary district regulations and procedures when discharging into the sanitary sewer system. Maintain sanitary facilities at all times without nuisance. Include provisions for pest control and elimination of odors. SDSTA toilet facilities will not be available to Contractor's personnel.
- B. Fire Protection

Provide temporary fire protection equipment for the protection of personnel and property during construction. Remove debris and flammable materials daily to minimize potential hazards.

1.8 TRAFFIC PROVISIONS

- A. Maintenance of Traffic

Conduct operations in a manner that will not close any thoroughfare or interfere in any way with traffic except with written permission of the Project Manager at least 15 calendar days prior to the proposed modification date.

1. Provide a Traffic Control Plan detailing the proposed controls to traffic movement for approval.
 2. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.
 3. Conduct work to minimize obstruction of traffic and always maintain traffic on at least half of the roadway.
 4. Obtain approval prior to starting any activity that will obstruct traffic.
- B. Dust Control
1. Dust control methods and procedures must be approved by the Project Manager.
 2. Treat dust abatement on access roads with applications of calcium chloride, water sprinklers, or similar methods or treatment.

1.9 CONTRACTOR'S TEMPORARY FACILITIES

- A. Appearance of Temporary Facilities
1. Trailers utilized by the Contractor for administrative or material storage purposes must present a clean and neat exterior appearance and be in a state of good repair.
 2. Keep fencing in a state of good repair and proper alignment.
 3. Grassed or unpaved areas, which are not established roadways, will be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways, should the Contractor elect to traverse them with construction equipment or other vehicles; gravel gradation will be at the Contractor's discretion.
- B. Security Provisions
- Provide adequate outside security lighting at the Contractor's temporary facilities. The Contractor will be responsible for the security of its own equipment.

1.10 CLEANUP

- A. Appearance of construction and storage areas must be maintained.
1. Remove construction debris, waste materials, packaging material and the like from the work site daily.
 2. Any dirt or mud which is tracked onto paved or surfaced roadways must be cleaned away.
 3. Store any salvageable materials resulting from demolition activities within the fenced area described above or at a supplemental storage area.
 4. Neatly stack stored materials not in trailers, whether new or salvaged.

1.11 RESTORATION OF STORAGE AREA

- A. Upon completion of the project remove bulletin boards, signs, barricades, haul roads, and any other temporary products from the site.
- B. Restore areas used by the Contractor for the storage of equipment or material, or other use to the original or better condition.
- C. Remove gravel used to traverse grassed areas and restore the area to its original condition, including topsoil and seeding as necessary.

END OF SECTION

SECTION 01 78 00

CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.1 DEFINITIONS

A. As-Built Drawings

As-built drawings are developed and maintained by the Contractor and depict actual conditions, including deviations from the Contract Documents. These deviations and additions may result from coordination required by, but not limited to contract modifications; official responses to Contractor submitted Requests for Information; direction from the Contracting Officer; designs which are the responsibility of the Contractor, and differing site conditions. Maintain the as-builts throughout construction as red-lined hard copies on site. These files serve as the basis for the creation of the record drawings by the A/E.

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. Product Data
2. Spare Parts Data
3. Manufacturer's Instructions
4. Posted Instructions
5. As-Built Drawings
6. Final Approved Shop Drawings

1.3 AS-BUILT DRAWINGS

A. Markup Guidelines

Make comments and markup the drawings complete without reference to letters, memos, or materials that are not part of the As-Built drawing. Show what was changed, how it was changed, where item(s) were relocated and change related details. These working as-built markup prints must be neat, legible, and accurate as follows:

1. Use base colors of red, green, and blue. Color code for changes as follows:
 - a. Special (Blue) - Items requiring special information, coordination, or special detailing or detailing notes.
 - b. Deletions (Red) - Over-strike deleted graphic items (lines), lettering in notes and leaders.
 - c. Additions (Green) - Added items, lettering in notes and leaders.

B. As-Built Drawings Content

Show on the as-built drawings, but not limited to, the following information:

1. The actual location, kinds, and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.
2. The location and dimensions of any changes within the building structure.

3. Layout and schematic drawings of electrical circuits and piping.
4. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures, or utilities if any changes were made from contract plans.
5. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to shop drawings, fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.
6. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.
7. Where contract drawings or specifications present options, show only the option selected for construction on the working as-built markup drawings.
8. Actual location of anchors, construction and control joints, etc., in concrete.
9. Unusual or uncharted obstructions that are encountered in the contract work area during construction.

1.4 CLEANUP

- A. Leave premises "broom clean."
- B. Clean interior and exterior glass surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to a sanitary condition. Replace filters of operating equipment.
- D. Clean debris from roofs, gutters, downspouts, and drainage systems.
- E. Sweep paved areas and rake clean landscaped areas.
- F. Remove waste and surplus materials, rubbish, and construction facilities from the site.

END OF SECTION

SECTION 02 41 00 DECONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Deconstruction Plan

1.2 DECONSTRUCTION PLAN

- A. Referenced Standards:
 - 1. Prepare a Deconstruction Plan and submit proposed deconstruction, and removal procedures for approval before work is started.
 - 2. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress,
 - a. A disconnection schedule of utility services.
 - b. A detailed description of methods and equipment to be used for each operation.
 - c. The sequence of operations.
 - 3. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be Removed.
 - 4. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use Include statements affirming Contractor inspection of the existing roof deck and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work.
 - 5. Provide procedures for safe conduct of the work in accordance with EM 385-1-1.
 - 6. Plan shall be approved by Contracting Officer.
- B. General Requirements
 - 1. Do not begin demolition or deconstruction until authorization is received from the Contracting Officer.
 - 2. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the buildings.
 - 3. Remove rubbish and debris from Government property daily, unless otherwise directed.
 - 4. Store materials that cannot be removed daily in areas specified by the Contracting Officer.
 - 5. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

1.3 ITEMS TO REMAIN IN PLACE

- A. Take necessary precautions to avoid damage to existing items to remain in place or to remain the property of the Government.
 - 1. Repair or replace damaged items as approved by the Contracting Officer. Coordinate the work of this section with all other work indicated.
 - a. Construct and maintain shoring, bracing, and supports as required.
 - b. Ensure that structural elements are not overloaded.
 - c. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.
 - d. Do not overload structural elements.
 - e. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work.
 - f. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

- B. Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction.
 - 1. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement.
 - 2. Provide protective measures to control accumulation and migration of dust and dirt in all work areas.
 - 3. Remove dust, dirt, and debris from work areas daily.
- C. Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations.
 - 1. Prior to start of work, utilities serving each area of alteration or removal will be shut off by the Government and the Government will disconnect and seal utilities serving each area of alteration or removal upon written request from the Contractor.
- D. Protect electrical and mechanical services and utilities.
 - 1. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
 - 2. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer.
 - 3. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. Deconstruction Plan
 - a. Existing Conditions
 - 2. Certificates
 - 3. Closeout Submittals

1.5 QUALITY ASSURANCE

- A. Submit timely notification of deconstruction renovation projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. site Environmental, Safety, and Health Advisor and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSP A10.6.
 - 1. Comply with the Environmental Protection Agency requirements specified.
 - 2. Use of explosives will not be permitted.
- B. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area.
 - 1. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

1.6 PROTECTION

- A. Traffic Control Signs
 - 1. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights.
 - a. Anchor barricades in a manner to prevent displacement by wind.
 - b. Notify the Contracting Officer prior to beginning such work.
- B. Protection of Personnel

1. Before, during and after the deconstruction work continuously evaluate the condition of the structure being deconstructed and take immediate action to protect all personnel working in and around the project site.
2. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.7 EXISTING CONDITIONS

- A. Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work.
 1. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal.
 - a. Photographs sized 100 mm 4 inch will be acceptable as a record of existing conditions.
 2. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work.
 3. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document.
 4. Submit survey results.

PART 2 - PRODUCTS

2.1 INSTALLATION

- A. Fill Material
 1. Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill basements, voids, depressions or excavations resulting from demolition or deconstruction of structures.

PART 3 - EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

- A. Inspect and evaluate existing structures onsite for reuse.
 1. Existing construction scheduled to be removed for reuse shall be disassembled.
 2. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.
- B. Disconnecting Existing Utilities
 1. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer.
 2. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area.
 3. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer.
- C. Paving and Slabs
 1. Remove sawcut concrete and asphaltic concrete paving and slabs including aggregate base.
- D. Concrete
 1. Saw concrete along straight lines to a depth of a minimum 2 inch.
 2. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face.

3. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound.
 4. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete.
- E. Conduit and Miscellaneous Items
1. Salvage conduit except where embedded in concrete or masonry.
 2. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type.
 3. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.2 DISPOSAL OF MATERIAL

- A. Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property.
- B. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, deconstruction, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction.
- C. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.3 CLEANUP

- A. Remove debris and rubbish from basement and similar excavations.
- B. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas.
- C. Apply local regulations regarding hauling and disposal.

END OF SECTION

SECTION 03 05 05
CONCRETE TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Contractor requirements for testing of concrete and grout.
 - 2. Definition of Contractor provided testing.
 - 3. Acceptance criteria for concrete.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

1.2 RESPONSIBILITY AND PAYMENT

- A. Contractor will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.
 - 1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
 - 2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
 - 3. Strength testing on concrete required by the Engineer or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
 - 4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
 - 5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re-removed.
 - 6. Contractor will pay for services defined in Paragraph 1.2A.1.
 - 7. See Specification Section 01 30 00.
- B. Hire a qualified testing agency to perform the following testing and provide test results to the Owner.
 - 1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
 - 2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
 - 3. Pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
 - 4. See Specification Section 01 30 00.
- C. Duties and Authorities of Testing Agency/Service Provider:
 - 1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
 - 2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.
 - 3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
 - a. All test reports to include exact location in the work at which batch represented by a test was deposited.
 - b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.

4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

- A. Referenced Standards:
 1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete.
 2. ASTM International (ASTM):
 - a. ASTM Cement and Concrete Reference Laboratory (CCRL).
 - b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - e. C94, Standard Specification for Ready-Mixed Concrete.
 - f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. C172, Standard Practice for Sampling Freshly Mixed Concrete.
 - h. C1019, Standard Test Method for Sampling and Testing Grout.
 - i. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- B. Qualifications:
 1. Contractor's Testing Agency:
 - a. Meeting requirements of ASTM E329 and ASTM C94.
 - b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.
- C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

- A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

- A. Shop Drawings:
 1. Product technical data including:
 - a. Concrete materials and concrete mix designs proposed for use.
 - 1) Include results of all testing performed to qualify materials and to establish mix designs.
 - 2) Place no concrete until approval of mix designs has been received in writing.
 - 3) Submittal for each concrete mix design to include:
 - a) Sieve analysis and source of fine and coarse aggregates.
 - b) Test for aggregate organic impurities.
 - c) Proportioning of all materials.
 - d) Type of cement with mill certificate for the cement.
 - e) Brand, quantity and class of fly ash proposed for use
 - f) Slump.
 - g) Brand, type and quantity of air entrainment and any other proposed admixtures.
 - h) Shrinkage test results.
 - i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.

- j) 28-day compression test results
 - k) Designed to meet require 90 C*m/W maximum Rho value.
- 2. Certifications:
 - a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

- A. The following concrete testing will be performed by the Service Provider/Testing Agency:
 - 1. Concrete strength testing:
 - a. Secure concrete samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
 - b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
 - 1) Record any deviations from requirements on test report.
 - 2) Cylinder size: Per ASTM C31.
 - a) 4 IN cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 IN.
 - b) Use the same size cylinder for all tests for each concrete mix.
 - 3) Quantity:
 - a) 6 IN DIA by 12 IN high: Four cylinders.
 - b) 4 IN DIA by 8 IN high: Six cylinders.
 - c. Field cure one cylinder for the seven day test.
 - 1) Laboratory cure the remaining.
 - d. Test cylinders in accordance with ASTM C39.
 - 1) 6 IN DIA cylinders:
 - a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
 - b) Hold remaining cylinder in reserve.
 - 2) 4 IN DIA cylinders:
 - a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
 - b) Hold remaining cylinders in reserve.
 - e. Strength test result:
 - 1) Average of strengths of two, 6 IN DIA cylinders or three, 4 IN DIA cylinders from the same sample tested at 28 days.
 - 2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
 - 3) Should all cylinders in any test show any of above defects, discard entire test.
 - f. Frequency of tests:
 - 1) Concrete sand cement grout: One strength test for each 4 HR period of grout placement or fraction thereof.
 - a) Test grout in accordance with ASTM C1019.
 - 2) Concrete topping, concrete fill and lean concrete: One strength test for each [10] [60] CUYD of each type of concrete or fraction thereof placed.
 - 3) Precast concrete: Frequency per Specification Section [03 41 33] [03 42 00].
 - 4) All other concrete:
 - a) One strength test to be taken not less than once a day, nor less than once for each 60 CUYD or fraction thereof placed in any one day.

- b) Once for each 5000 SQFT of slab or wall surface area placed each day
 - c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.
- 2. Slump testing:
 - a. Determine slump of concrete sample for each strength test.
 - 1) Determine slump in accordance with ASTM C143.
 - b. If consistency of concrete appears to vary, the Engineer or Owner's Representative shall be authorized to require a slump test for each concrete truck.
 - 1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.
- 3. Air content testing: Determine air content of concrete sample for each strength test in accordance with [ASTM C231][, ASTM C173][, or] [ASTM C138.]
- 4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

- A. Any Owner required inspections listed in Sections 01.
- B. Formwork Special Inspections:
 - 1. Shape, location, and dimensions.
 - a. Inspect in accordance with dimensions and details on Drawings.
 - b. Frequency: Inspect prior to each concrete pour.
- C. Reinforcing Special Inspections:
 - 1. Reinforcing size, spacing, lap length and concrete cover.
 - a. Inspect in accordance with Drawings and Specification.
 - b. Frequency: Inspect prior to each concrete pour.
 - 2. Reinforcing adhesive anchoring system:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all adhesive anchors for the first [4] HRS of installation.
 - 2) Inspect approximately [25]% of adhesive anchors thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
 - 3. Mechanical splices:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all mechanical splices [prior to placing concrete] [for the first [4 HRS] of installation].
 - 2) Inspect approximately [25]% of mechanical splices thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
- D. Mixing, Placing, Jointing, and Curing Special Inspections:
 - 1. Perform concrete tests per the requirements of this Specification Section.
 - 2. Verification of proper mix design.
 - a. Frequency: Periodically, prior to [each] concrete pour.
 - 3. Proper concrete placement techniques.
 - a. Inspect per requirements of Section 03 31 31.
 - b. Frequency: During [each] concrete pour.
 - 4. Proper curing temperature and techniques.
 - a. Inspect per requirements of Section 03 31 31.
 - b. Frequency: Periodically, but not less than [every third day].
 - 5. Joints:
 - a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.

- b. Frequency: Prior to each concrete pour.
- 6. Waterstops:
 - a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
 - b. Frequency:
 - 1) Prior to each concrete pour.
- E. Anchorage to Concrete Special Inspection:
 - 1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Engineer.
 - a. Frequency: Per ICC-ES Report.
 - 2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
 - a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

- A. To facilitate testing and inspection, perform the following:
 - 1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
 - 2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.
 - 3. Take samples at point of placement into concrete member.
- B. Notify Owner's and Contractor's Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

- A. Completed concrete work which meets applicable requirements will be accepted without qualification.
- B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
- C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
 - 1. In this event, modifications may be required to assure that concrete work complies with requirements.
 - 2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.
- D. Dimensional Tolerances:
 - 1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
 - 2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
 - a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
 - 3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
 - 4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
 - a. Repair or remove and replace if required.
 - 5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
 - a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

- E. Appearance:
 - 1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
 - 2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.
- F. High Water-Cement Ratio:
 - 1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
 - 2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.
- G. Strength of Structure:
 - 1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
 - a. Low concrete strength:
 - 1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
 - a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
 - b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
 - c) A strength test shall be the average of two, 6 IN diameter cylinders or three, 4 IN diameter cylinders from the same sample tested at 28 days.
 - 2) Acceptance:
 - a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
 - (1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.
 - (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 PSI.
 - b. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
 - c. Curing time and procedure not meeting requirements of this Specification Section.
 - d. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - e. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
 - f. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
 - 2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
 - 3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
 - a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
 - 1) Such tests shall not be used as a basis for acceptance or rejection.
 - b. Core tests:
 - 1) Where required, test cores will be obtained in accordance with ASTM C42.
 - a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DEGF, relative humidity less than 60%) for seven days before test then test dry.

- b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.
 - c) Testing wet or dry to be determined by Engineer.
- 2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
 - a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
 - b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
- 3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85% of specified strength and no single core is less than 75% of specified strength.
- 4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.
- 4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.
- 5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
- 6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

SECTION 03 31 31
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mixing, placing, jointing, and curing of concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 05 05 - Concrete Testing and Inspection.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. 304.2R, Placing Concrete by Pumping Methods.
 - e. 305R, Guide to Hot Weather Concreting.
 - f. 305.1, Specification for Hot Weather Concreting.
 - g. 306R, Guide to Cold Weather Concreting.
 - h. 306.1, Standard Specification for Cold Weather Concreting.
 - i. 308.1, Specification for Curing Concrete.
 - j. 309R, Guide for Consolidation of Concrete.
 - k. 318, Building Code Requirements for Structural Concrete and Commentary.
 - l. 360R, Guide to Design of Slabs-on-Ground.
 - 2. ASTM International (ASTM):
 - a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 3. Corps of Engineers (COE):
 - a. CRD-C572, Specifications for Polyvinylchloride Waterstop.
 - 4. National Ready Mixed Concrete Association (NRMCA):
 - a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
- B. Qualifications:
 - 1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.
 - 2. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction, and at no additional cost to Owner.
- C. Pre-Concreting Conference:
 - 1. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 30 days after the Notice to Proceed.

- a. Schedule the meeting to occur no later than [five] days in advance of the first scheduled date of concrete placement.
2. All parties involved in the concrete work shall attend the conference, including:
 - a. Contractor's representative.
 - b. Testing laboratory representative/inspectors.
 - c. Concrete subcontractor.
 - d. Reinforcing steel installer.
 - e. Concrete supplier.
 - f. Owner.
 - g. Resident Engineer or Project Representative.
 - h. Design Engineer.
 - i. Building Code Official.
3. The conference shall be held at a mutually agreed upon time and location.
4. The agenda shall include but not be limited to the following:
 - a. Scheduling, sequence and notification of concrete placements.
 - b. Contractor's concrete pre-placement plan checklist.
 - c. Delivery time from batch plant, maximum time in truck, and approved exceptions to the limits.
 - d. Review of approved design mix including the limits of water that can be added and who is authorized to add water, if water has been withheld at the plant.
5. Additional test cylinders for structural elements the Contractor intends to subject to live loads earlier than 28 days.
6. Duties and authority of testing and inspection agency.
7. Curing procedures.
8. Temperature/weather issues.
9. Test cylinder storage and protection.
10. Approval and rejection of work.
11. Mock-up panels as the standard.

1.3 DEFINITIONS

- A. Words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 1) Procedure for adding high-range water reducer at the jobsite.
 - c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
 - d. Manufacturers and types:
 - 1) Joint fillers.
 - 2) Curing agents.
 - 3) Construction joint bonding adhesive.
 - 4) Waterstops.
 2. Certifications:
 - a. Ready mix concrete plant certification.
- B. Informational Submittals:
 1. Copies of concrete delivery tickets.
 2. Description of proposed curing methods.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Concrete Delivery:
 1. Prepare a delivery ticket for each load of ready mixed concrete.

2. Truck operator shall hand ticket to Contractor at the time of delivery.
3. Ticket to show:
 - a. Mix identification.
 - b. Quantity delivered.
 - c. Amount of material in each batch.
 - d. Outdoor temperature in the shade.
 - e. Time at which cement was added.
 - f. Time of delivery.
 - g. Time of discharge.
 - h. Amount of water that may be added at the site without exceeding the specified water-cement ratio.
 - i. Amount of any approved water added at the site.

1.6 PROJECT CONDITIONS

- A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
 1. Do not use revised concrete mixes until submitted to and approved by Engineer.

1.7 SEQUENCING AND SCHEDULING

- A. Do not begin concrete production until proposed concrete mix design has been approved by Owner.
 1. Approval of concrete mix design does not relieve Contractor of his responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.
- B. Neoprene Expansion Joint Fillers:
 1. Acceptable manufacturers:
 - a. Permaglaze.
 - b. Rubatex.
 - c. Williams Products.
 2. Materials:
 - a. Closed cell neoprene.
 - b. ASTM D1056, Type 2, Class A or C.
 - c. Grade: Compression deflection as required to limit deflection to 25% of joint thickness under pressure from concrete pour height.
- C. Asphalt Expansion Joint Fillers:
 1. Acceptable manufacturers:
 - a. W.R Meadows.
 - b. J and P Petroleum Products.
 2. Materials: ASTM D994.
- D. Fiber Expansion Joint Fillers:
 1. Materials: ASTM D1751.
- E. Waterstops, PVC Type:
 1. Acceptable manufacturers:
 - a. Sika Greenstreak Plastic Products.
 - b. W.R Meadows.
 - c. Vinylex Corporation.
 - d. Bometals, Inc.
 2. Materials:

- a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
 - b. Cast-in-place type: COE CRD-572.
 - 3. Approved profiles as listed.
 - a. Construction joints:
 - 1) Ribbed: 6 IN wide by 3/8 IN.
 - 2) Sika Greenstreak Plastic Products Style #679, or equal.
 - b. Control joints:
 - 1) 6 IN wide by 3/8 IN thick with ribs and center bulb.
 - 2) Sika Greenstreak Plastic Products Style #705, or equal.
 - c. Expansion joint:
 - 1) 9 IN wide by 3/8 IN thick center bulb 2 inch OD.
 - 2) Sika Greenstreak Plastic Products Style #739, or equal.
 - 4. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum 6 IN clear of the intersection.
 - 5. Factory prepunched (less than 18 IN centers, each edge, staggered) for wire supports.
 - a. Provide hog rings or grommets at all punched holes along the length of the waterstop.
 - 6. See Drawings for application and other requirements.
- F. Waterstops, Preformed Strip Type:
- 1. Acceptable manufacturers:
 - a. Sika Greenstreak Plastics, Inc. (Hydrotite).
 - b. Adeka Ultra Seal USA (MC-2010MN).
 - c. DeNeef (Swellseal 2010).
 - 2. Hydrophilic, non-bentonite composition.
 - 3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
 - 4. Volumetric expansion limited to 3 times maximum.
 - 5. See Drawings for application and other requirements.
- G. Water Swelling Sealant:
- 1. Required adhesive for use with strip-type waterstop.
 - 2. Compatible with strip-type waterstop.
 - 3. Single component, gun applied.
 - 4. Moisture cured.
 - 5. Minimum 70% volumetric expansion swelling capability.
- H. Curing Products to conform to one or more of the following:
- 1. Absorbent Covers.
 - 2. Moisture Retaining Covers.
 - a. Moisture Retaining Fabric.
 - 3. Dissipating curing compound:
 - a. Fugitive dye, waterborne, membrane-forming.
 - b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions so as to not impair the later addition and performance of applied finishes.
 - c. Acceptable Products:
 - 1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
 - 2) Euclid Chemical Company (The); Kurez DR VOX.
 - 3) L&M Construction Chemicals, Inc.; L&M Cure R.
 - 4. Clear, [water] [or] [solvent]-borne, membrane-forming curing and sealing compound:
 - a. ASTM C1315, Type 1, Class A.
 - b. Moisture loss shall be not more than 0.40 KG/M² when applied at 300 SQFT/GAL.
 - c. Manufacturer's certification is required.

- d. Subject to project requirements, provide one of the following products:
- e. Products:
 - 1) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
 - 2) L&M Construction Chemicals, Inc.; Lumiseal Plus.
 - 3) Meadows, W.R., Inc.; CS-309/30.
 - 4) Euclid Chemical Company; Super Diamond Clear VOX.
 - 5) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - 6) Meadows, W.R., Inc.; Vocomp-30.
- I. Sand cement grout, non-shrink grout and epoxy grout: ASTM C1107/C1107M.

2.2 SOURCE QUALITY CONTROL

- A. The concrete plant shall conform to the Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
- B. The concrete should have a designed mix, from Geotherm or others, to reach a maximum rho value of 90 C*m/W.

PART 3 - EXECUTION

3.1 PREPARATION

- A. General:
 - 1. All materials and construction shall conform to the tolerances as specified in ACI 117.
 - 2. Complete formwork.
 - 3. Remove earth, snow, ice, water, and other extraneous/foreign materials from areas that will receive concrete.
 - 4. Secure reinforcement in place.
 - 5. Position expansion joint material, anchors and other embedded items.
 - 6. Obtain approval of formwork, reinforcement installation and placement prior to placing concrete.
 - 7. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and prior Engineer approval is obtained.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
 - b. Do not allow rainwater to increase mixing water nor to damage surface finish.
 - 8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
 - 9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
 - a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.
- B. Preparation of Subgrade for Slabs On Ground:
 - 1. Subgrade to be wetted without standing water immediately prior to placing concrete.
 - 2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
- C. Edge Forms and Screeds:
 - 1. Set accurately to produce designated elevations and contours of finished surface.
 - 2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
 - 3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

- A. General:

1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
 2. Batch, mix, and transport in accordance with ASTM C94/C94M.
- B. Control of Admixtures:
1. Control at the batch plant:
 - a. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.
 - b. Charge admixtures into mixer as solutions.
 - 1) Measure by means of an approved mechanical dispensing device.
 - 2) Liquid considered a part of mixing water.
 - 3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
 - c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
 - d. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.
 2. Control of Admixtures in the field:
 - a. Additional quantities of admixtures (with the exception of retarders) may be added in the field provided:
 - 1) Addition of admixtures shall be under the supervision of the ready mix quality control representative.
 - 2) Addition of each admixture to be documented on the delivery ticket.
 - 3) Provide additional mixing per ASTM C94.
- C. Tempering and Control of Mixing Water:
1. Mix concrete only in quantities for immediate use.
 2. Discard concrete which has set.
 3. Discharge concrete from ready mix trucks within time limit stated in ASTM C94.

3.3 PLACING OF CONCRETE

- A. General:
1. Place concrete as such a rate that concrete, which is being integrated with fresh concrete, is still workable.
 - a. Select placement equipment and manpower in order to assure timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
 2. Comply with ACI 304R and ACI 304.2R.
 3. Do not begin placing concrete during rain, sleet, or snow.
 - a. Protect fresh concrete from ensuing inclement weather.
 4. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
 5. Begin work only when work of other trades affecting concrete is complete.
 6. Do not use excess grout or mortar to lubricate lines when pumping concrete.
 7. Do not use excess water for workability or any reason when placing concrete by freefall.
 8. Deposit concrete continuously to avoid cold joints.
 9. Locate construction joints at locations specified or approved by Engineer.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
 10. Spreaders:
 - a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
 - b. Embedded:
 - 1) Obtain approval of Engineer for their use.
 - 2) Materials: Concrete or metal.
 - 3) Ends of metal spreaders coated with plastic coating 2 IN from each end.

11. Deposit concrete as nearly as practicable in its final position to avoid segregation.
 - a. Maximum free fall: 4 FT.
 - b. Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface.
 12. Perform the following operations before bleeding water has an opportunity to collect on surface:
 - a. Spread.
 - b. Consolidate.
 - c. Straightedge.
 - d. Darby or bull float.
 13. No water shall be added to the concrete surface to ease finishing operation.
 14. Do not discharge water into forms.
 15. Consider use of form vibrators for certain placement situations.
- B. Cold Weather Concrete Placement:
1. Comply with ACI 306.1.
 2. Do not place concrete on forms or subgrades that are below 32 DEGF or contain frozen material.
 3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
 4. Temperature of concrete when discharged at site: Per ACI 306.1.
 5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 DEGF, when temperature of surrounding air is 40 DEGF or below at time concrete is placed.
 - a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
 6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DEGF.
 7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DEGF.
 8. Follow ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.
- C. Hot Weather Concrete Placement:
1. Comply with ACI 305.1.
 2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
 3. Temperature of concrete at point of delivery (i.e. truck discharge) when placed:
 - a. Not to exceed 90 DEGF.
 - b. Not so high as to cause:
 - 1) Shrinkage cracks.
 - 2) Difficulty in placement due to loss of slump.
 - 3) Flash set.
 4. Temperature of forms and reinforcing when placing concrete:
 - a. Not to exceed 90 DEGF.
 - b. May be reduced by spraying with water to cool below 90 DEGF.
 - 1) Leave no standing water to contact concrete being placed.
 5. Prevent plastic shrinkage cracking and/or slab curling due to evaporation.
- D. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
 2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
 - a. Ensure no displacement of reinforcing or other embeds from final position.
 - b. Eliminate:
 - 1) Air or stone pockets.
 - 2) Honeycombing or pitting.
 - 3) Planes of weakness.

3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
 - a. Size and coordinate external vibrators to specifically match forming system used.
 4. Internal vibrators:
 - a. Minimum frequency of 8000 vibrations per minute.
 - b. Insert and withdraw at points approximately 18 IN apart.
 - 1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
 - c. Use in:
 - 1) Beams and girders of framed slabs.
 - 2) Columns and walls.
 - 3) Vibrating concrete around all waterstops.
 - d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
 5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
 6. Do not use vibrators to transport concrete within forms.
 7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the work.
 8. Provide sufficient spare vibrators on jobsite during all concrete placing operations to assure continuous vibration.
 9. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
 10. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.
- E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
 2. Horizontal belt conveyors:
 - a. Mount at a slope which will not cause segregation or loss of ingredients.
 - b. Protect concrete against undue drying or rise in temperature.
 - c. Use an arrangement at discharge end to prevent segregation.
 - d. Do not allow mortar to adhere to return length of belt.
 - e. Discharge conveyor runs into equipment specially designed for spreading concrete.
 3. Metal or metal lined chutes:
 - a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
 - b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
 - c. Provide end of each chute with a device to prevent segregation.
 4. Pumping or pneumatic conveying equipment:
 - a. Designed for concrete application and having adequate pumping capacity.
 - b. Control pneumatic placement so segregation is avoided in discharged concrete.
 - c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
 - d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
 - e. Provide pumping equipment without Y sections.
- F. Placing of Concrete on Metal Deck:
1. Prior to concrete placement, the metal deck shall be free of soil, debris, standing water, loose mill scale, and all other foreign matter.
 2. Care shall be exercised when placing concrete so that the deck will not be subject to construction loads or impact that exceed the design capacity of the deck.

3. Concrete shall be placed in a uniform manner and spread toward the center of the deck span.
4. If buggies are used to place concrete, runways shall be planked, and the buggies shall only operate on planking.
 - a. Planks shall be of adequate stiffness to transfer loads to the steel supports without damaging the deck.
5. Deck damage caused by careless placement of concrete shall be repaired or replaced.
6. Pour concrete to the thickness noted on Drawings.

3.4 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - General:

1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
 - a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Specification Section.
2. Unplanned construction joints will not be allowed.
 - a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
 - a. At Contractor's option, beam pockets may be formed into concrete walls.
 - b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
5. Place beams, girders, column capitals and drop panels at same time as slabs.
6. Place corbels monolithically with their supporting members.
 - a. Locate wall vertical construction joints midway between corbels.
 - b. Where only a single corbel is located, place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
8. Provide the following joints unless noted otherwise on Drawings:
 - a. Roughen joints: horizontal construction joints.
 - b. Keyed joints: vertical construction joints.
9. Roughen construction joints:
 - a. Clean the previously hardened concrete interface and remove all laitance.
 - b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
10. Keyways:
 - a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or as directed by Engineer.
 - b. Wall keys:
 - 1) Keyway width, not less than 1/3 and not more than 1/2 the wall thickness measured perpendicular to wall faces.
 - 2) Keyway depth to be not less than 1-1/2 IN.
 - 3) Continuous along length of wall.
 - 4) Place keyway in wall center unless shown otherwise on Drawings.
 - c. Keyways in footings, foundations, base slabs, and structural or elevated slabs:
 - 1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
 - 2) Keyway depth not less than 1-1/2 IN.
 - 3) Continuous along footing or slab.
 - 4) Keyway in footing or slab center unless shown otherwise on Drawings.
 - d. Beam keyways:
 - 1) Full width of beam.
 - 2) Keyway height not less than 5-1/2 IN.

- 3) Keyway depth not less than 1-1/2 IN.
 - 4) Keyway located in initial beam pour, directly above the bottom reinforcing, unless shown otherwise on Drawings.
11. Minimum time before placement of adjoining concrete construction:
- a. All [other] concrete: 60 HRS, unless otherwise noted.
- B. Construction Joints - Spacing Unless Otherwise Specified:
1. Structures not intended to contain liquid:
 - a. Base slab, floor, and roof slab construction joints:
 - 1) Placements to be approximately square and not to exceed 2500 SQFT.
 - 2) Maximum side dimension of a slab pour to be [70] FT.
 - b. Floor slab, construction joints:
 - 1) Placements to be approximately square and not to exceed 2000 SQFT.
 - 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 60 FT.
 - c. Elevated slab construction joints:
 - 1) Placements to be approximately square and not to exceed 2500 SQFT.
 - 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 70 FT.
- C. Construction Joints - Bonding:
1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
 2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as outlined below:
 3. Roughen construction joints:
 - a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 1/4 IN minimum amplitude.
 - 1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
 4. Keyed construction joints:
 - a. Thoroughly clean construction joints and remove all laitance.
 - b. Dampen the hardened concrete immediately prior to placing of fresh concrete.
- D. Slab On Grade Joints:
1. Locate construction and control joints in slabs on grade as indicated on Drawings.
 2. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
 - a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
 - b. Complete before shrinkage stresses become sufficient to produce cracking.
- E. Expansion Joints:
1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
 2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
 3. Seal expansion joints:
 - a. Provide sealants compatible with the material(s) to which they are applied. Do not use a sealant that has exceeded its shelf life or has jelled and cannot be discharged in a continuous flow from the sealant gun.
 - b. Apply sealants in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width.
 - c. Work sealant into joints so as to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion.
 - d. Apply sealant uniformly smooth and free of wrinkles.

- e. Upon completion of sealant application, roughen partially filled or unfilled joints, apply additional sealant, and tool smooth as specified.
 - f. Apply sealer over sealants in accordance with the sealant manufacturer's printed instructions.
- Waterstops - General:
- 4. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
 - 5. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
 - 6. Preformed strip type:
 - a. Locate waterstop at center of wall, unless noted otherwise on Drawings.
 - 1) Maintain at least 3 IN from edge of concrete or as recommended by manufacturer.
 - b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
 - c. Roughened joints shall be especially prepared during concrete placement to provide smooth surface for proper water stop installation.
 - d. Use in joints against existing concrete where indicated on Drawings.
 - 7. PVC waterstops:
 - a. Pre-position waterstop accurately in joints, with adequate clearance from all reinforcing. Do not push waterstop into wet concrete.
 - b. Secure waterstops in correct position using hog rings or grommets spaced no more than 18 IN maximum staggered along each edge full length and passed through the edge of the waterstop.
 - 1) Tie wire to adjacent reinforcing.
 - c. Hold horizontal waterstops in place with continuous supports.
 - d. Install according to manufacturer's instructions.
 - 1) Do not displace reinforcement from required location.
 - e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
 - 1) Use factory fabricated "T" and corner intersection fittings.
 - 2) Field splice straight runs of material.
 - f. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.
- F. Other Embedded Items:
- 1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
 - a. Give Contractor whose work is related or integral to concrete, or supported by it, ample notice and opportunity to furnish and install items before placing concrete.
 - 2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.
- G. Placing Embedded Items:
- 1. Support against displacement.
 - 2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
 - 3. Provide adequate means for anchoring waterstop in concrete.
 - a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.5 FINISHING

- A. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

- A. Grout Schedule:
 - 1. Sand cement grout:

- a. Fill keyways in precast HCU.
 - b. Construction joint bedding (base of wall pours with comparable compressive strength to wall).
 - c. General use.
 - d. As noted on Drawings.
 - 2. Non-shrinking non-metallic grout:
 - a. Filling form tie holes.
 - b. Under column and beam base plates.
 - c. Other uses indicated on the Drawings.
 - 3. Epoxy grout:
 - a. Patching cavities in concrete.
 - b. Grouting of dowels and anchor bolts into existing concrete.
 - c. Grouting of rotating or oscillating equipment base plates [where driving motor is 500 HP and above].
 - d. As noted on the Drawings.
- B. Grout Installation:
- 1. Sand cement grout:
 - a. Fill wetted keyways between precast concrete hollow core slabs with sand cement grout.
 - b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
 - c. Cure grout by one of methods specified.
 - 2. Non-shrink non-metallic grout:
 - a. Clean concrete surface to receive grout.
 - b. Saturate concrete with water for 24 HRS prior to grouting.
 - c. Mix in a mechanical mixer.
 - d. Use no more water than necessary to produce flowable grout.
 - e. Place in accordance with manufacturer's instructions.
 - f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast slabs, and in other locations indicated on the Drawings.
 - g. Completely fill all spaces and cavities below the top of base plates.
 - h. Provide forms where base plates and bed plates do not confine grout.
 - i. Where exposed to view, finish grout edges smooth.
 - j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
 - k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
 - 3. Epoxy grout:
 - a. Mix and place in accordance with manufacturer's instructions.
 - b. Apply only to clean, dry, sound surface.
 - c. Completely fill all cavities and spaces around dowels and anchors without voids.
 - d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
 - e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

- A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
 - 1. Follow recommendations of ACI 308.1 except as modified herein.
 - 2. Do not impose loads by foot traffic, wheeled traffic, and other loads until concrete has sufficiently cured to carry imposed loads without adversely affecting the concrete. In no event shall concrete be subject to loading or traffic during initial 48 HRS of curing, unless otherwise approved by Engineer.

- B. Apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
1. Ponding or continuous sprinkling. Take care to avoid eroding the surface of freshly placed concrete.
 2. Application of wet Absorbent Covers:
 - a. Minimum lap: 12 IN.
 - b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as required to keep concrete surface continuously wet.
 - c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
 3. Continuous application of steam (not exceeding 150 DEGF) or mist spray.
 4. Application of Moisture Retaining Cover sheet materials.
 - a. Place as soon as possible after final finishing and without marring the surface.
 - b. Minimum lap: 12 IN.
 - c. Seal all edges to make water-tight.
 - d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
 - e. Hold cover and edges in place as required to prevent wind from displacing the cover.
 - f. Moisture Retaining Fabric:
 - 1) Install in accordance with manufacturer's written recommendations.
 - 2) Saturate concrete surface and fabric side of cover immediately prior to placing.
 - g. Monitor continuously during the curing period:
 - 1) Repair any holes, tears or displaced cover.
 - 2) Rewet as required to keep concrete moist under cover.
 5. Application of other moisture retaining covering as approved by Engineer.
 6. Water used for curing shall be within 20 DEGF of the concrete temperature.
 7. Application of a curing compound.
 - a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
 - b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
 - c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
 - 1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
 - 2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - 3) Allow the preceding coat to completely dry prior to applying the next coat.
 - 4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
 8. Surfaces In Contact with Forms:
 - a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
 - b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
 - c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
 - d. After form removal, cure concrete until end of time prescribed.
 - e. Use one of the methods listed above.
 - f. Forms left in place shall not be used as a method of curing in hot weather.
 - g. The term "hot weather", where used in these specifications, is defined in ACI 305.1.
 - h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

C. Curing Period:

1. Continue curing for at least seven days for all concrete.
 - a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.
- D. Cold Weather:
 1. Follow recommendations of ACI 306.1.
 2. Maintain temperature of concrete per ACI 306.1 for a minimum of 72 HRs after concrete is placed, when outdoor temperature is 40 DEGF, or less.
 - a. Maximum temperature rate of decrease: Per ACI 306.1.
 3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
 4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
 5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.
- E. Hot Weather:
 1. Follow recommendations of ACI 305.1 and ACI 308.1.
 2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
 3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
 4. Maximum temperature rate of decrease: Per ACI 305.1.
- F. Rate of Temperature Change:
 1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.
- G. Protection from Mechanical Injury:
 1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
 2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
 3. Do not load self-supporting structures in such a way as to overstress concrete.

END OF SECTION

SECTION 26 05 00
ELECTRICAL - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic requirements for electrical systems.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 03 - Concrete.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Aluminum Association (AA):
 - a. ADM, Aluminum Design Manual.
 - 2. American Institute of Steel Construction (AISC):
 - a. Steel Construction Manual.
 - 3. American National Standards Institute (ANSI).
 - 4. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C2, National Electrical Safety Code (NESC).
 - 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 7. National Electrical Manufacturers Association (NEMA):
 - 8. Underwriters Laboratories, Inc. (UL).
- B. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.
 - 1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.
 - 2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

1.3 DEFINITIONS

- A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
 - 1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
 - 2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
 - 3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
 - 4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
 6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.
- B. Maintain Site Operation:
1. All existing equipment in the pump station must be operational prior to beginning the phased construction.
 - a. Coordinate with the [Owner's] operations and maintenance staffs to verify they have equipment operational and construction can proceed.
 - b. Comply with the requirements of Specification Section 01 30 00.
- C. Execution of this Contract will involve replacement of existing equipment.
1. The Contractor is responsible for coordinating with the Engineer and the Owner those site which shall remain in service, or which shall have a limited downtime, and to schedule his work accordingly.
 2. Temporary equipment and wiring, installed in accordance with the NFPA70, may be used if necessary to maintain operation or to limit downtime.
 3. Under no circumstances shall equipment be taken out of service without the Owner's permission.
 4. Comply with requirements of Specification Section 01 30 00.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specifications in Section 01 61 03 for any other submittal requirements for products defined as equipment.
 2. General requirements:
 - a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
 - b. Include data sheets that include manufacturer's name and product model number.
 - 1) Clearly identify all optional accessories.
 - c. Acknowledgement that products are NRTL listed or are constructed utilizing NRTL recognized components.
 - d. Manufacturer's delivery, storage, handling and installation instructions.
 - e. Product installation details.
 - f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
 - g. See individual specification sections for any additional requirements.
 3. Fabrication and/or layout drawings:
 - a. Concrete and reinforcing steel, per Division 03 requirements.
- B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 00 and 01 78 00 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content process of Operation and Maintenance Manuals.
 - c. Close-out Submittals
- C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

- A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
1. Outdoor areas:

- a. Wet.
- b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
- 2. Indoor areas:
 - a. Dry.
 - b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.
- B. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

- A. Electrical Equipment Support Pedestals and/or Racks:
 - 1. Manufacturers:
 - a. Modular strut:
 - 1) Unistrut Building Systems.
 - 2) B-Line by Eaton.
 - 3) Globe Strut.
 - 4) Superstrut by Thomas & Betts.
 - 2. Material requirements:
 - a. Modular strut:
 - 1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
 - 2) Stainless steel: AISI Type 316.
 - 3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 MIL PVC coating.
 - 4) Aluminum: AA Type 6063-T6.
 - 5) Fiberglass: Fire-retardant polyester or vinylester resin, ASTM E84, UL 94.
 - b. Structural members (e.g., I beams, L and C channels):
 - 1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
 - 2) Aluminum: AA Type 6061-T6 or 6063-T6.
 - c. Mounting plates:
 - 1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
 - 2) Aluminum: AA Type 6063-T6.
 - d. Mounting hardware:
 - 1) Galvanized steel.
 - 2) Stainless steel.
 - e. Anchorage per Drawing Set
 - f. Concrete: See Division 03 specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.
- B. Install equipment in accordance with the requirements of:
 - 1. NFPA 70.

2. IEEE C2.
 3. The manufacturer's instructions.
- C. In general, conduit routing is not shown on the Drawings.
1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
 2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.
- D. When complete branch circuiting is not shown on the Drawings:
1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
 2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
 3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
- E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.
- F. Install equipment plumb, square and true with construction features and securely fastened.
- G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.
- H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.
- I. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 6 IN in equipment location with the Owner's approval.
- J. Provide electrical equipment support system per the following area designations:
1. Dry areas:
 - a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
 - b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
 2. Wet areas:
 - a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
 - b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
 3. Corrosive areas:
 - a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
 4. Highly corrosive areas:
 - a. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.
- K. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
1. Do not cut, or weld to, building structural members.
 2. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

- L. Provide non-metallic corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.
- M. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.
- N. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.
- O. Do not use materials that may cause the walls or roof of a building to discolor or rust.
- P. Identify electrical equipment and components in accordance with NFPA 70 and other applicable codes.
- Q. Provide field markings and/or documentation of available short-circuit current (available fault current) and related information for equipment as required by the NFPA 70 and other applicable codes.
- R. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 - 1. Determine the SCCR rating by one of the following methods:
 - a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 - 2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
 - 3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

3.2 FIELD QUALITY CONTROL

- A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
- B. Replace equipment and systems found inoperative or defective and re-test.
- C. Cleaning:
 - 1. See Specification Section 01 74 19.
- D. The protective coating integrity of support structures and equipment enclosures shall be maintained.
 - 1. Repair galvanized components utilizing a zinc rich paint.
 - 2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
 - 3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
 - 4. Repair surfaces which will be inaccessible after installation prior to installation.
 - 5. See Specification Section 26 05 33 for requirements for conduits and associated accessories.
- E. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

- A. Demonstrate equipment in accordance with Manufactures instructions.

END OF SECTION

SECTION 26 05 13

MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Medium voltage cable (601 V and above).
 - b. Cable terminations and splices.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 26 05 00 - Electrical - Basic Requirements.
 - 2. Section 26 08 00 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Association of Edison Illuminating Companies (AEIC).
 - a. CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 48, Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
 - b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
 - c. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
 - d. 400.3, Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment.
 - e. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV.
 - 3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
 - a. WC 74/S-93-639, 5 - 46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
 - 4. InterNational Electrical Testing Association (NETA):
 - a. ATS, Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - 5. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 6. Underwriters Laboratories, Inc. (UL):
 - a. 1072, Standard for Medium-Voltage Power Cables.
- B. Qualifications:
 - 1. Cable technician:
 - a. Three years of experience in handling, terminating and splicing medium voltage cables.
 - b. Specifically trained by a factory representative on the terminations and splices to be used on the project.
 - 1) If not trained on the products to be used, on-site training by the factory representative shall be performed before any terminations or splices are made.
 - 2. Cable testing:

- a. The independent testing organization shall have been engaged in full practice in the final inspection, testing, calibration, and adjusting of electrical distribution systems, for a minimum of five years.
- b. The independent testing organization shall have a calibration program with accuracy traceable every six months in an unbroken chain, to NIST.
- c. The independent testing organization shall have a designated safety representative for the project.
 - 1) The standards followed shall include OSHA, NFPA 70E [and IEEE 510].
- d. Inspection, testing, and calibration shall be performed by an engineering technician, certified by a national organization, such as the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET), with a minimum of five years experience inspecting, testing, and calibrating electrical equipment, systems and devices.
 - 1) Information on the certified engineering technician shall be submitted to the Engineer for approval prior to the start of work.
- e. The qualifications of the independent testing organization shall be submitted to the Engineer for approval prior to the start of testing.
 - 1) Full membership to the InterNational Electrical Testing Association constitutes proof of meeting all of the above requirements.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - 2. Fabrication and/or layout drawings:
 - a. Cable pulling plan.
- B. Informational Submittals:
 - 1. Cable pulling tension measurements or photograph of breakaway swivel attached to cable.
 - 2. Submit the following before terminating cables:
 - a. Cable Technician qualifications.
 - 3. Submit the following before testing:
 - a. Independent testing organization qualifications.
 - 4. Provide a comprehensive report that identifies numerically and graphically the magnitude of partial discharge leakage current detected for each circuit and each cable section tested.
 - 5. Cable test report(s) shall include, at a minimum, the following:
 - a. Summary of Project.
 - b. Date tests were performed.
 - c. Description of equipment/components tested.
 - d. Visual inspection report.
 - e. Description of tests.
 - f. Test results including appropriate test forms.
 - g. Conclusions and recommendations for corrective action as appropriate.
 - h. Identification of test equipment used.
 - i. Identification of company and person that performed the tests.
 - j. Reports signed by the engineering technician or engineer interpreting the data.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Wire and cable:
 - a. The Okonite Company.
 - b. Prysmian Group.
 - c. Southwire Company.
 - 2. Lugs, connectors and terminations:
 - a. 3M.
 - b. Elastimold by Thomas & Betts.
 - c. Eaton Cooper Power Systems.

2.2 MEDIUM VOLTAGE CABLES

- A. Ratings:
 - 1. 15 kV class unless otherwise indicated on the Drawings.
- B. Standards:
 - 1. NEMA/ICEA WC 74/S-93-639.
 - 2. AEIC CS8.
 - 3. UL 1072.
- C. Conductor Material:
 - 1. Compact stranded aluminum.
- D. Insulation:
 - 1. Temperature rating: MV-105 per NFPA 70.
 - 2. Ethylene-propylene-rubber (EPR).
 - 3. 133% insulation level.
- E. Shielding:
 - 1. Shielding on cables rated above 2 kV consists of:
 - a. Semiconductor conductor screen.
 - b. Semiconductor insulation screen.
 - c. Copper tape or copper wire
- F. Grounds:
 - 1. Insulated copper per Specification Section 26 05 19.
- G. Jackets:
 - 1. Direct buried cables shall be rated for direct bury.
 - 2. Jacket: Polyethylene

2.3 CABLE ACCESSORIES

- A. Lugs and Connectors:
 - 1. Lugs:
 - a. Compression type.
 - b. Standard: UL 486B for aluminum and copper cables.
 - c. Voltage rating: Up to 35 kV.
 - d. Current rating: Continuous operation at the rating of the cable.
 - e. Material: Tin-plated copper
 - f. Number of holes: Two.
- B. Terminations:
 - 1. End caps:
 - a. Cold or hot shrink.
 - b. Used to environmentally seal and mechanically protect exposed cable ends.
 - 2. Cold shrink kits:

- a. Standard: IEEE 48, Class 1 termination.
- b. Voltage rating: Same as the cable rating.
- c. Current rating: Continuous operation at the rating of the cable.
- d. One-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber.
- e. Suitable for contaminated indoor and outdoor locations.
- 3. Molded rubber kit:
 - a. Standard: IEEE 48.
 - b. Voltage rating: Same as the cable rating.
 - c. Current rating: Continuous operation at the rating of the cable.
 - d. One-piece design or modular with stress cone and skirts, where high-dielectric constant stress control is integrated within a skirted insulator made of EPDM rubber.
 - e. Suitable for contaminated indoor and outdoor locations.
- 4. Elbow connectors:
 - a. Standard: IEEE 386.
 - b. Voltage rating: Same as the cable rating.
 - c. Current rating: 200A.
 - d. One-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
 - e. Deadfront, loadbreak type with:
 - 1) Hot stick pulling eye.
 - 2) Grounding tab.
 - 3) Test point.
 - f. Accessories to be constructed in a similar manner as the elbow connector:
 - 1) Bushing inserts.
 - 2) Bushing well plugs.
 - 3) Feed thru inserts.
 - 4) Protective caps.
- C. Cable Shield Grounding Adapters:
 - 1. Type: Molded rubber with constant force spring and solder-blocked tinned copper braid pigtail.
 - 2. Waterproof, providing a positive seal for the cable jacket.
 - 3. May be integral with termination of splice device with Engineer's approval.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Do not install cable during wet conditions.
 - 1. Prior to pulling cables, drain or pump out manholes and other low points if standing water is present.
 - 2. Blow out conduits with dried compressed air if moisture is present in conduits.
 - 3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.
 - a. If end caps are damaged, remove and install new end caps.
 - b. Do not remove end caps until ready to terminate or splice cable.
- B. Cable Installation in Manholes:
 - 1. Provide enough cable slack in each manhole for a complete loop around the manhole.
 - a. When cable is spliced in a manhole, provide enough cable slack for a complete loop around the manhole.
 - b. The loop will provide slack to facilitate future cable repairs.
- C. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.

- D. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for each shielded cable termination.
 - 1. Select correct termination to match cable diameter and construction.
 - 2. Form and install terminations in strict accordance with instructions of cable manufacturer and termination manufacturer.
- E. The ground shield grounding adaptors shall be grounded:
 - 1. Shired and elbow terminators: Grounded to ground bar or cable loop in equipment.
 - 2. Splices: Grounded to ground bar or rod in manhole.
 - 3. Connect with insulated, stranded #6 AWG wire.

3.2 FIELD QUALITY CONTROL

- A. Cable pulling plan.
 - 1. Underground ductbanks: Include proposed splice points, cable pulling direction for each pull, and estimated pulling tensions (tension calculation).
 - a. Include unreeling tensions, sheave radius, lubrication coefficient of friction, etc. in the calculation.
 - b. Identify any cable pulling aids necessary to not over tension the cable during the pull. For example: motorized cable reel roller, lubrication quantity.
 - c. Identify all devices to be used to attach cables to puller. For example, wire grips, swivels, slings.
 - 2. Above grade raceways: Include proposed splice points, cable pulling direction for each pull, and estimated pulling tensions (tension calculation).
 - a. Include pull box sizing calculations.
 - b. Identify any cable pulling aids necessary to not over tension the cable during the pull. For example, cable reel roller, lubrication quantity.
 - c. Identify all devices to be used to attach cables to puller. For example, wire grips, swivels, slings.
- B. When estimated pulling tension is greater than 75% of cables maximum allowed tension, provide measurement of tensions during the pull or use breakaway swivel of a strength less than the cable's maximum allowed tension.
- C. After all terminations and splices have been made, and prior to connections to equipment, provide the following acceptance tests in accordance with NETA ATS:
 - 1. Shield continuity test.
 - 2. DC high-potential test or time domain partial discharge test.
- D. Non-destructive Partial discharge test.
 - 1. Perform the work while the medium voltage circuits and equipment are energized.
 - a. The cables shall not be disconnected or de-energized and the testing shall not expose the cables to voltages that exceed normal operating voltage.
 - 2. Use a frequency domain detection process incorporating a spectrum analyzer with radio frequency current transformer (RF CT) sensors.
 - a. The detection system, including spectrum analyzer, RF CTs and interconnecting cable, shall have a partial discharge detection range that at least covers the frequency range of 10 KHz to 300 Mhz.
 - b. Testing shall be performed in a manner that complies with the requirements of IEEE 400 and IEEE 400-3.
- E. See Specification Section 26 08 00 for acceptance testing requirements.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for grounding and bonding system(s).
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 26 05 00 - Electrical - Basic Requirements.
 - 2. Section 26 08 00 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
 - 3. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 4. Society of Cable Telecommunications Engineers (SCTE):
 - a. 77, Specification for Underground Enclosure Integrity.
 - 5. Underwriters Laboratories, Inc. (UL):
 - a. 467, Grounding and Bonding Equipment.
- B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
 - 1) Grounding clamps, terminals and connectors.
 - 2) Exothermic welding system.
 - b. See Specification Section 26 05 00 for additional requirements.
 - 2. Fabrication and/or layout drawings:
 - a. Plan drawing(s) showing type, size and locations of all grounding system components.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 00 and 01 78 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - b. Close-Out Submittals

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Ground rods and bars and grounding clamps, connectors and terminals:
 - a. ERICO by Pentair.
 - b. Harger Lightning & Grounding.

- c. Heary Bros. Lightning Protection Co. Inc..
- d. Burndy by Hubbell.
- e. Robbins Lightning, Inc.
- f. Blackburn by Thomas & Betts.
- g. Thompson Lightning Protection, Inc.
- 2. Exothermic weld connections:
 - a. ERICO by Pentair - Cadweld.
 - b. Harger Lightning & Grounding - Ultraweld.
 - c. Burndy by Hubbell - Thermoweld.
 - d. FurseWELD by Thomas & Betts.

2.2 COMPONENTS

- A. Wire and Cable:
 - 1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
- B. Conduit:
 - 1. Schedule 40 PVC conduit, gray, when buried
 - 2. Schedule 80 PVC conduit, gray, when above ground
- C. Ground Bars:
 - 1. Solid copper:
 - a. 1/4 IN thick.
 - b. 2 or 4 IN wide.
 - c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
 - 2. Predrilled grounding lug mounting holes.
 - 3. Stainless steel or galvanized steel mounting brackets.
 - 4. Insulated standoffs.
- D. Ground Rods:
 - 1. [3/4 IN x 10 FT] [, or as indicated on the Drawings].
 - 2. Copper-clad:
 - a. 10 MIL minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
 - b. Corrosion resistant bond between the copper and steel.
 - c. Hard drawn for a scar-resistant surface.
- E. Grounding Clamps, Connectors and Terminals:
 - 1. Mechanical type:
 - a. Standards: UL 467.
 - b. High copper alloy content.
 - 2. Compression type for interior locations:
 - a. Standards: UL 467.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Terminals for connection to bus bars shall have two bolt holes.
 - 3. Compression type suitable for direct burial in earth or concrete:
 - a. Standards: UL 467, IEEE 837.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Factory filled with oxide inhibiting compound.
- F. Exothermic Weld Connections:
 - 1. Copper oxide reduction by aluminum process.
 - 2. Molds properly sized for each application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install products in accordance with manufacturer's instructions.
 - 2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
 - 3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
 - 4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install sleeve per Specification Section 01 73 20.
 - a. Seal the sleeve interior to stop water penetration.
 - 5. Do not splice grounding electrode conductors except at ground rods.
 - 6. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
 - a. Provide excavation required for installation of ground rods and conductors.
 - b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
 - c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
 - d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
 - e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
 - 7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.
- B. Grounding Electrode System:
 - 1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
 - a. All grounding electrode conductors terminate on a main ground bar located adjacent to the service entrance equipment.
 - 2. Grounding electrode conductor terminations:
 - a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.
 - b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
 - c. Piping systems: Use mechanical type connections.
 - d. Building steel, below grade and encased in concrete: Use compression type connector or exothermic weld.
 - e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or exothermic weld.
 - f. Ground rod: Compression type or exothermic weld, unless otherwise specified.
- C. Supplemental Grounding Electrode:
 - 1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
 - a. See Grounding Electrode System paragraph for conductor termination requirements.
 - b. Grounding conductor: Bare 4/0 AWG minimum.
 - 2. Equipment support rack and pedestals mounted outdoors:
 - a. Connect metallic structure to a ground rod.
 - b. Grounding conductor: #6 AWG minimum.
- D. Equipment Grounding:
 - 1. Ground all utilization equipment with an equipment grounding conductor.

- E. Manhole and Handhole Grounding:
 - 1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
 - a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
 - 2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.
- F. Pad Mounted Switch and Above Grade Sectionalizer Box Grounding:
 - 1. Per detail on the Drawings.
 - 2. Provide a ground rod(s) in each enclosure with a minimum of 4 IN of rod exposed above the floor for connection to the rod.
 - 3. Connect metal frame to the ground rod.
 - 4. Connect medium voltage cable shields to the ground rod.
- G. Precast Cable Trench:
 - 1. Provide a bare grounding conductor run with the power cables at the base of the trench.
 - a. Conductor, #4 AWG minimum, or sized equal to the largest conductor run within the trench.
 - 2. Bond trench grounding conductor to ground grid.
 - 3. Make metal cable trays within the trench electrically continuous with a minimum of one grounding lug installed per tray section and bonded to the trench ground conductor.
 - 4. Bond all associated conduits to the trench ground conductor.
 - 5. Bond RGS conduit run within the trench to the trench grounding conductor at all entrances and exits to the trench.

3.2 FIELD QUALITY CONTROL

- A. Leave grounding system uncovered until observed by Owner.
- B. Acceptance testing:
 - 1. See Specification Section 26 08 00.

END OF SECTION

SECTION 26 05 46

OVERHEAD POWER LINES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Construction of overhead power lines.
 - 2. See appendix for staking sheets, stringing charts and pole framing details.
- B. Related Specification Sections include but are not necessarily limited to:

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A475, Standard Specification for Zinc-Coated Steel Wire Strand.
 - b. B232/B232M, Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR).
 - 2. American National Standards Institute (ANSI):
 - a. O5.1, Wood Poles - Specifications and Dimensions.
 - 3. American Wood Protection Association (AWPA):
 - a. P8, Standard for Oil-Borne Preservative Systems.
 - b. P9, Standard for Solvents and Formulations for Organic Preservative Systems.
 - c. U1, Use Category System: User Specification for Treated Wood.
 - 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 524, Guide to the Installation of Overhead Transmission Line Conductors.
 - b. C2, National Electrical Safety Code (NESC).
 - c. C62.11, Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV).
 - 5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
 - a. C29.2, Insulators - Wet Process Porcelain and Toughened Glass - Transmission Suspension Type.
 - b. C29.3, Wet-Process Porcelain Insulators - Spool Type-.
 - c. C29.4, Wet-Process Insulators - Strain Type-.
 - d. C29.5, Wet-Process Porcelain Insulators - Low and Medium Voltage Types.
 - e. C119.4, Electric Connectors - Connectors for Use between Aluminum-to-Aluminum and Aluminum-to Copper Conductors Designed for Normal Operation at or Below 93 DEGC and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100 DEGC.
 - 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
- B. Qualifications:
 - 1. Erection and installation by personnel skilled in power line construction for the electric utility industry, experienced in construction projects of similar size and character as required for this Work.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. A complete list of all materials to be supplied by the Contractor by description and manufacturer's catalog number.
 - 1) This material list will be submitted 30 days after Award of Contract.
 - b. Contractor to provide a list of miscellaneous materials needed to complete the job.

- 1) Miscellaneous items are defined as nuts, bolts, washers, etc., for complete installation.
2. Test reports:
 - a. Pole Inspection Reports by independent Agency.
- B. Operation and Maintenance Manuals.
 1. See Specification Section 01 33 00 and 01 78 00 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.
 - c. Close-Out Submittals
- C. Informational Submittals:
 1. Record of measurements made during sagging operations.
 2. Record of clearance measurements.
 3. Record of final grounding measurements at each structure (if required).

1.4 PROJECT/SITE CONDITIONS

- A. Field Measurements:
 1. Obtain all necessary field dimensions.
 2. Prospect for and locate all subgrade facilities which are either part of the Work, or are nearby and must be protected.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Poles:
 1. Acceptable species:
 - a. Southern yellow pine.
 2. Conform to ATIS O5.1 except as modified herein.
 3. Smoothly trimmed by machine.
 4. Drilled and gained per structure drawings for this Work prior to treatment.
 5. Conform to AWPA U1 for pressure treatment.
 6. Preservative shall be an oil type or water borne preservative conforming to AWPA P8 and AWPA P9, respectively.
 7. Treatment shall meet penetration requirements of REA Specification DT-5C:PE-9 for Area 2 use.
 8. Southern yellow pine:
 - a. Loblolly, longleaf, shortleaf or slash species.
 - b. Treated full length by pressure process.
 9. Free from imperfections except as follows:
 - a. Deviation from straightness in short crook (any 5 FT section or less) not to exceed 2 IN.
 - b. Sweep (curvature from top to bottom):
 - 1) Where in one plane in one direction only, a straight line connecting center of butt with center of top shall not at any intermediate point pass through the external surface of the pole.
 - 2) Where in two planes, or in two directions in one plane, a straight line connecting the center of the butt with the center of the top shall not deviate from the centerline of the pole more than 1/4 diameter of the pole at the point of widest deviation.
 - c. Scars permitted per ATIS O5.1 provided:
 - 1) Depth of trimmed scar not more than 1 IN if pole diameter at location of scar is 10 IN or less.
 - 2) Depth of trimmed scar not more than 1/10 of pole diameter at location of scar, if such diameter is more than 10 IN.
 - d. Spiral grain: No more than 1 complete twist of grain in any 16 FT length.
- B. Crossarms:

1. West coast Douglas fir.
 2. Drilled per structure drawings before treatment.
 3. Pentachlorophenol (nonpressure process).
- C. Bare Conductors:
1. Aluminum-composition conductors:
 - a. Aluminum conductor steel reinforced (ACSR) per ASTM B232/B232M, neoprene covered.
 - 1) 556 ACSR, Dove.
 2. Steel conductors (for shield wire):
 - a. Extra high strength steel without brazed or welded joints, Class B galvanizing, meeting requirements of ASTM A363.
- D. Insulators (Porcelain):
1. Suspension insulators per NEMA/ANSI C29.2, Class 52-2.
 2. Spool type insulators per NEMA/ANSI C29.3, Class 53-2.
 3. Guy strain insulators per NEMA/ANSI C29.4, Class 54-3.
 4. Medium and low voltage pin insulators per NEMA/ANSI C29.5, Class 55-5.
 5. Insulators rated 6000 V and above shall be interference proof.
 6. Sky gray color, except where indicated otherwise.
 7. See Drawings for approved unit(s).
- E. Surge Arresters:
1. Metal oxide type.
 2. Manufactured per IEEE C62.11.
 3. Equipped with mounting brackets suitable for the indicated installations.
 4. See Drawings for approved unit(s).
- F. Switches:
1. Outdoor type.
 2. Gang operated switches to be complete with operating mechanism, handle, etc.
 3. Grounding mechanism
- G. Guy Wire and Accessories:
1. Guy wire shall be extra high strength steel, 7 strand, Class B galvanizing, 42400 LBS minimum breaking strength, meeting requirements of ASTM A475.
 2. Strength of attachments, insulators and other accessories shall exceed strength of guy strand.
 3. Guy marker shall be yellow polyvinyl, fiberglass, or other suitable plastic material, not less than 8 FT in length.
 - a. Each guy wire is to have a guy guard.
 4. Guy Strain Insulators: 8 FT long minimum,.
- H. Anchors:
1. Furnish power installed screw anchors, except furnish expanding type rock anchor for anchoring in solid rock.
 2. Rod shall be hot-dip galvanized with eye contoured to prevent damage to guy(s).
 3. Anchor shall be [asphalt coated] [hot-dip galvanized], except expanding rock anchors which shall be painted.
- I. See Drawings for approved unit(s). Connectors:
1. Copper alloys for copper conductors, aluminum alloys for aluminum composition conductors, type designed to minimize galvanic corrosion for copper to aluminum composition.
 2. For bare connections, conform to NEMA/ANSI C119.4 for aluminum composition and aluminum composition to copper.
 3. All connections shall be compression type, except where specifically required otherwise.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Staking:
 - 1. Stake the line accurately determining the field position of each pole and anchor.
 - 2. Notify Engineer for inspection and approval of staking locations immediately after staking line and prior to beginning construction.
 - 3. Staking of angle structures to be offset on the bisector of the angle to compensate for rake in poles and insulator swing so that conductors will hang over true center line in their normal unloaded condition (provide offset indicated in Drawings where specified).
 - 4. Locate structures by stake at center of pole hole.
 - 5. Locate anchors by stake at location where anchor rod, in installed position, shall protrude from the ground.
 - 6. Relocate and replace any stakes which are missing or damaged prior to installation of the facilities.
- B. Determine phasing of the existing system.

3.2 DEMOLITION

- A. General:
 - 1. Remove the facilities designated in the Contract Documents.
 - 2. Cleanup practices shall be in accordance with the General Conditions.
 - 3. No facilities designated for removal shall be reused in this Work, except those items specifically authorized for reuse in the Contract Documents or approved by the Owner.
- B. Removal:
 - 1. Use procedures which are safe and guarantee no hazard to personnel or other facilities.
 - 2. Remove items which Owner desires to salvage, or which are designated for reuse in this Work, in a manner so that they will not be damaged.
 - 3. For poles:
 - a. Completely remove, including pole butts.
 - b. Fill holes with dry, clean soil, pneumatically or hydraulically tamped in a manner which will prevent future settlement, 6 IN lifts maximum. (top 18 IN to be top soil).
 - 4. Anchors shall be completely removed if possible; otherwise, cut off at least 3 FT below the ground line.
 - 5. For removal of concrete, neatly cut boundary of area designated for removal with suitable power saw.
- C. Disposition:
 - 1. Items designated in the Contract Documents for reuse in this Work shall be temporarily stored at Contractor's storage site until required.
 - 2. The following items shall become property of Contractor for disposal in accordance with local ordinances:
 - a. All material and equipment designated for removal which Owner does not desire to salvage.
 - b. Concrete rubble.
 - c. Excess backfill from holes.
 - 3. Not be required to dispose of any equipment containing oil with PCB content of 50 ppm or greater.

3.3 INSTALLATION

- A. Field modifications of wood poles and crossarms:
 - 1. Field drilling in crossarms not permitted.
 - 2. For poles, field drill any necessary bolt holes not provided by factory.
 - a. Diameter of holes to be 1/16 IN larger than bolt.

- b. Through center of pole.
 - c. Treat holes with Copper Naphthenate, Chromated Copper Arsenate (CCA).
 - 3. Field gain poles for any crossarm mountings not gained by factory.
 - a. Perpendicular to bolt holes.
 - b. 1/2 IN maximum depth.
 - c. Treat with 5% pentachlorophenol solution.
 - 4. Swab any unused holes (including holes created by removing equipment from existing structures) in poles or crossarms with 5% pentachlorophenol solution and then plug with treated wood plugs.
 - 5. No top of any pole shall be cut off, unless approved by Engineer/Owner.
 - 6. In no case shall butt of any pole be cut off.
- B. Structure Framing and Assembly:
- 1. Use extra heavy, large, choice, close-grained poles for deadend, angle, crossing and corner structures.
 - 2. Frame in accordance with the Drawings.
 - 3. Completely assemble structure prior to setting except the grounding conductor, if installed on standoff brackets, shall be installed after setting pole.
 - 4. Use of bucket trucks shall be maximized.
 - 5. Use slings for lifting poles.
 - 6. On joint-use structures, reserve vertical pole space suitable for communications facilities in accordance with IEEE C2 requirements and Drawings.
 - 7. The loose end of the grounding down leads shall be looped over the pole top and temporarily secured prior to wire stringing (for protecting pole from lightning until shield wire is installed).
 - 8. Bolts, nuts and washers:
 - a. Nuts to be drawn tight so as to obtain full strength of all hardware fittings.
 - b. Spring washers and lockwashers, where required, to be fully compressed.
 - c. Install locknut with each nut, eyenut or other fastener on all bolts and threaded hardware (such as insulator pins, upset bolts, double arming bolts, etc.).
 - d. Bolts shall not extend less than 2 threads or more than 2 IN beyond nuts.
 - 9. Lag screws:
 - a. Driven into pole to within 1 IN of the head.
 - b. Finish by turning with wrench until completely installed.
 - 10. Pole Bands (if applicable):
 - a. Select appropriate size in field.
 - b. Use minimum size which will provide at least 2 threads behind locknuts.
 - c. Grooving or notching of pole, or use of filler plate to accommodate band not permitted.
 - d. Give approximately equal lengths of surplus threads on either end of the stud bolts.
 - e. Equal separation between sections.
 - f. Stud bolts to which guys are attached shall be in line with the guy strain.
 - 11. Other Hardware:
 - a. Install without damage to threads, galvanizing or splintering of pole or arms.
- C. Structure Erection:
- 1. Alignment:
 - a. Set structures within 3 IN of correct location (except minor adjustment permitted on poles with substantial sweep or crook so that conductors will be in line).
 - b. Poles of tangent structures shall be vertical with crossarms, where used, at right angle to the line.
 - 2. Installed structure shall have no damage to wood fibers, preservative treatment, equipment, hardware, insulators or other structure components.
 - 3. When lowering the poles into holes, or aligning them, use no sharp bars or other objects at or below ground line which could damage the poles.
 - 4. Setting depths: 10% of pole height plus 2 FT.

POLE LENGTH (FT)	SETTING DEPTH IN SOIL (FT)	SETTING DEPTH IN ROCK (FT)
45	7.5	4.5

5. All poles shall be set at depths specified above for soil, except as described below.
6. Use setting depths for rock provided:
 - a. Hole is substantially vertical.
 - b. Diameter of hole is uniform and not greater than twice the diameter of the pole.
 - c. Hard rock covers the complete circumference of hole. (If solid rock is separated by layers of earth, shale, coal, sandstone, sand, hardpan, or loose rock use soil setting depth.)
 - d. Sufficient room for tamping full depth of hole.
7. For layer of earth over solid rock, depth of hole to be that specified for solid rock plus depth of earth layer (but not to exceed soil setting depth).
8. On sloping ground, measure depth of the hole from the low side of the hole.
9. For holes dug too deep, fill with crushed rock or concrete to correct depth.
10. Hole to be dug straight and approximately 12 IN larger than the largest diameter of pole butt.
11. Explosives shall not be used for removal of rock.
12. Remove all water and mud from hole prior to backfilling.
13. Backfill with crushed rock, except where specified otherwise.
14. For crushed rock backfill:
 - a. Use crushed limestone rock or other Engineer approved aggregate.
 - b. Grading:

WEIGHT (PERCENT)	TO PASS	SIZE OF MESH (IN)
100	1 IN Screen	1.000
60 to 90	1/2 IN Screen	0.500
40 to 60	No. 4 Screen	0.187
25 to 50	No. 8 Screen	0.0937
20 to 40	No. 16 Screen	0.0469
5 to 15	No. 200 Screen	0.0029.

- c. Backfill all but top 12 IN with crushed rock.
 - d. Backfill top 12 IN of hole with finely divided earth.
 - e. Bank earth around pole to height of 12 IN above ground line.
 15. Thoroughly compact backfill using pneumatic or machine tampers the full depth of the hole, 6 IN lifts maximum.
 16. Inspect backfill after the first few rainstorms and refill and tamp any settlement.
 17. Remove any surplus excavation material from site and dispose of in manner suitable to Owner.
- D. Guy and Anchor Installation:
1. Install at locations shown in the Contract Documents in accordance with manufacturer's recommendations.
 2. Anchor rods to be aligned with guy strain.
 3. For power installed screw anchors:
 - a. Determine soil classification by visual inspection of augered pole hole.
 - b. Soil classifications are as follows:

CLASS	SOIL TYPE DESCRIPTION
-------	-----------------------

0	Sound, hard rock unweathered
1	Very dense and/or cemented sands; coarse gravel and cobbles
2	Dense fine sand; very hard silts and clays
3	Dense clays, sands and gravel; hard silts and clay
4	Medium dense sandy gravel; very stiff to hard silts and clays
5	Medium dense coarse sand and sandy gravels; stiff to very stiff silts and clays
6	Loose to medium dense fine to coarse sand; firm to stiff clays and silts
7	Loose fine sand; Alluvium; loess; soft-firm clays; varied clays; fill
8	Peat, organic silts; inundated silts; fly ash

- c. Required holding strength for each anchor:
 - 1) 10 IN single Helix: 10,000 LBS.
 - 2) 10 IN double Helix: 20,000 LBS.
 - 3) Triple Helix: 35,000 LBS.
 - 4) Quad Helix: 40,000 LBS.
- d. Install screw anchors in soil classes 3 to 6.
- e. Use alternate anchoring method for soil classes 1 and 2 (screw anchor cannot be installed).
- f. For class 7 or 8 soil, install anchor extension rods to reach a class 3 to 6 soil (holding capacity of class 7 or 8 soil not satisfactory).
 - 1) Maximum of four total extension rods on any one anchor (one normal and three extra).
- g. Anchor, with rod eye correct distance out of the ground, to be in sufficient depth of class 3 to 6 soil to develop required holding strength.
- h. Do not exceed the maximum torque recommended by Manufacturer.
4. After installation, but before installation of guy, install marker by anchor rod eye to prevent damage from moving equipment.
5. Before putting strain on structures:
 - a. All guying to be in place.
 - b. Install any temporary guying necessary for stringing operations.
6. Anchor creep during stringing to be 2 IN or less.
7. After conductors are clipped-in:
 - a. Remove any temporary guying.
 - b. Eyes of all anchor rods to be between 3 IN and 9 IN above ground level.
 - c. No structure shall be bowed.
 - d. All guys on structure to share strain equally so as not to place any extra strain on one guy or the pole.
 - e. Adjust guying and true-up structures as necessary.
8. Install guy marker at each anchor (not required on the lower of two guys to the same rod).
- E. Grounding:
 1. Install according to the Drawings.
 2. Install ground lead in manner which prevents whipping in wind, and also undue stress during cold temperatures.
 3. Drive ground rods full length in undisturbed earth, with top of rod not less than 1 FT below grade.
 4. For sectional ground rods, use steel driving studs which do not damage the threads.
- F. Conductor Stringing:
 1. Install all conductors (phase, shield, neutral, messenger, etc.) indicated in the Drawings.
 2. Follow recommendations of conductor manufacturer.
 3. Furnish all ropes and other necessary equipment.

4. Provide reliable communication facilities for crews, suitable to Owner.
5. Install any necessary temporary guying.
6. Do not string conductors if adverse weather conditions are predicted before sagging and clipping-in can be completed.
7. In the event of storm with high winds while conductor is in stringing sheaves:
 - a. Conductor subject to Owner's inspection.
 - b. Assist by providing personnel and equipment as requested.
 - c. Repair or replace any damaged conductor to Owner's satisfaction.
8. Conductors, after installation, shall have no cuts, kinks, abrasions or other injuries.
 - a. Continuously inspect conductor as it leaves reel.
 - b. Repair any damaged conductor in accordance with requirements herein.
 - c. Advise Owner's representative of any repairs made.
9. Protect existing facilities.
 - a. Install sufficient guard structures of adequate strength as required, in opinion of Contractor, to maintain adequate clearance over buildings, roads, railroads, communication and power lines, etc.
 - b. Provide warning signs and lighting as necessary to prevent a hazard to public.
10. Use stringing equipment acceptable to Engineer:
 - a. Stringing sheaves:
 - 1) Sheave diameter and groove construction in accordance with recommendations of IEEE 524.
 - 2) Roller or ball bearings with provisions for lubrication.
 - b. Cable grips:
 - 1) Swivel connection to pulling line.
 - 2) Stocking type grip.
 - c. Tensioning equipment (for controlled tension stringing):
 - 1) Double bull-wheel type.
 - 2) Bullwheel diameter and groove construction in accordance with recommendations of IEEE 524.
 - 3) Neoprene-lined grooves.
 - 4) Capable of maintaining preset tensions not less than 10,000 LBS.
 - 5) Failsafe type braking system.
 - 6) Equipped with tension indicating and limiting devices.
 - d. Provide Engineer complete manufacturer's data on equipment prior to beginning of Work.
11. Provide adequate grounding for stringing equipment and conductors and use procedures which guarantee safety.
12. Pulling tension to be minimum required to provide clearance to ground and obstructions (not to exceed 90% of sagging tension).
13. No overload strains, drilling of temporary holes, or abrasion of any permanent structure.
14. Mounting of stringing sheaves on structure:
 - a. Sheaves shall hang freely without binding.
 - b. All sheaves in stringing section shall hold conductor at uniform distance, within 2 FT above or below, of location it will be when clipped-in.
 - c. Use two sheaves in tandem if conductor angle exceeds 30 DEG.
15. Splices not permitted to be pulled through stringing sheaves.
16. Controlled tension stringing:
 - a. Use for stringing conductors near energized circuits.
 - b. Use where stringing by slack method is not practical (areas with poor vehicle access, urban areas with roads and other obstructions, etc.).
 - c. Use for any other conductor (Contractor's option).
 - d. Use double bull-wheel type tension equipment to maintain continuous tension on conductors.
 - e. Use no equipment or procedure which would cause outer layer of conductor strands to loosen as it passes over bullwheel.
 - f. Provide light and steady back tension on conductor reel to prevent overrun.

- g. Observe all clearances during pulling.
 - h. Do not allow conductors to contact ground, guard structures or any other object which, in opinion of Owner, could cause abrasion or damage.
 - i. When left unattended, provide safe clearance between conductors in string sheaves and ground or other objects.
 - j. The slope of the conductor between the stringing equipment and the stringing sheave at the first structure not to be steeper than three horizontal to one vertical.
17. Slack stringing:
- a. Use for any conductors where controlled tension stringing is not required.
 - b. Pay out conductor from rotating reel.
 - c. Control speed of reel during pay out in a manner which prevents backlash and overrunning.
 - d. Application of breaking to conductor reels to provide tension for pulling specifically prohibited.
 - e. Do not pull conductor over rocks, pavement, fences, crossarms, or any other abrasive material or sharp object.
 - f. Provide suitable guards, supports or other precautions necessary to prevent damage.
 - g. Do not allow trucks, trailers or other vehicles to be driven over conductor.
 - h. Do not allow conductor to be pulled through mud, wet ground, water, etc.
 - i. Raise conductors to stringing sheaves as soon as possible.
 - j. Do not leave conductors on the ground overnight.

G. Conductor Sagging:

- 1. Follow recommendations of conductor manufacturer.
- 2. Sag conductors in accordance with the sag and tension charts furnished by Engineer.
 - a. Sagging charts are attached in Appendix at the end of this Specification Section.
 - b. Use sags and tensions identified as "Initial".
- 3. Prestretching of conductors not required.
- 4. Length of segment sagged in one operation to be limited to the length that can be sagged satisfactorily.
- 5. Sag only during good weather conditions.
 - a. Relatively constant temperature, no excessive wind.
 - b. Owner reserves the right to stop sagging operations if he considers weather conditions to be excessive.
- 6. Measure air temperature with certified etched-glass thermometer.
 - a. Place in basket made from conductor (remove internal strands as necessary to permit insertion of thermometer).
 - b. Suspend from structure in position near and parallel to the conductors being sagged for at least 1/2 HR before sagging.
- 7. Conductor to hang freely in stringing sheaves, clear of the ground, a minimum of 2 HRS before being sagged.
- 8. Properly tension conductors by measuring sags in the following spans:
 - a. For sagging five spans or less:
 - 1) Select one level span near the end remote from pulling point, so that length is equal to or greater than the ruling span.
 - 2) Measure sag by target method using transit modified as necessary for pole mounting.
 - b. For sagging more than five spans:
 - 1) Select one span near the end remote from pulling point.
 - 2) Select one span near the pulling point.
 - 3) Select one span near the middle (required only if sagging more than one reel length).
 - 4) Each span selected shall be approximately level with length equal to or greater than the ruling span.
 - 5) Measure all sags simultaneously by target method using transits modified as necessary for pole mounting or stopwatch method.

- c. Also check sags in the following spans (regardless of sagging length):
 - 1) All spans greater than 350 FT in length.
 - 2) For angles over 10 DEG, check span either side of angle structure.
 - 3) Measure either by target or stopwatch method.
 - 9. Record all data regarding sagging operations including:
 - a. Specific spans measured.
 - b. Tension and sag measurements.
 - c. Temperature corresponding to measurements.
 - 10. Sags will be verified by Owner's representative.
 - a. Not necessarily the same spans used for sagging.
 - b. Target or stopwatch method, at Owner's option.
 - c. Assist by providing personnel and equipment as requested.
 - d. Resagging of incorrectly sagged spans to be done at expense of Contractor.
 - 11. Sags in all spans shall be as required by the sagging charts, except the following tolerances are permitted:
 - a. No minus tolerance.
 - b. Plus tolerance not to exceed 1 IN per 100 FT of span length, with maximum of 6 IN.
 - c. All conductors in span having same required sag must not differ by more than 1-1/2 IN.
 - 12. Spacer Cable (aerial cable systems) shall be installed per manufacturer's recommendations.
 - a. Procedures will be supplied at Pre-Construction Conference.
 - b. See Appendix C for Hendrix information.
 - c. Taps and deadends shall be installed per instructions.
- H. Clipping-In:
 - 1. Clip-in conductors after obtaining required sags.
 - a. Clipping-in shall be no closer than three spans from next sagging operation.
 - b. Clip-in remaining structures after sagging next section.
 - 2. Maximum time between stringing and clipping-in:
 - a. Week days: 36 HRS.
 - b. Weekends or inclement weather: 72 HRS.
 - c. If above times are exceeded:
 - 1) Conductor subject to inspection by Owner.
 - 2) Assist by providing personnel and equipment as requested.
 - 3) Conductor shall be replaced at Contractor's expense if conductor distortion, abrasion or damage due to vibration has occurred.
 - 3. After clipping-in, suspension insulators must assume proper position.
 - a. Within 3 IN of plumb on tangent structures.
 - b. Equalize conductor tensions between successive sagging operations so that insulators on segments already clipped-in remain within above tolerance.
 - 4. Remove temporary facilities after clipping-in, fill any holes and restore area to near original condition suitable to Owner.
 - 5. Retighten all bolts and hardware.
- I. Jumpers:
 - 1. Install in neat and workmanlike manner.
 - 2. Install with adequate clearance from structure.
 - 3. Provide sufficient slack to allow free movement of conductors to which the jumpers are attached.
 - 4. Form smooth loop with no sharp bends, kinks or "cork screws".
 - 5. All jumpers should have current carrying capability equal or larger than main conductors.
- J. Installation of Insulators, Conductor Hardware and Accessories:
 - 1. Insulators:
 - a. Inspect before and after installation.
 - b. Remove damaged units from work site immediately.
 - c. Clean all porcelain surfaces and wipe to a bright finish.

- d. When raising suspension strings, use procedure which guarantees no damage to sockets or pins.
 - e. No climbing on insulators.
 - f. Pin and post insulators to be tight on pins or brackets.
 - g. Insulator groove (clamp) to be in line with conductor.
 - h. For orientation of retaining pins and cotter pins, see below.
2. Conductor Hardware:
- a. Handle in manner to prevent contact with ground.
 - b. Horizontal bolts or pins to have the nut or cotter on the pole side of the connection.
 - c. Vertical bolts or pins to have the nut or cotter on underside of the connection.
 - d. Horizontal ball and socket connections to have the cotter pins with eyes on top.
 - e. Vertical ball and socket connections to have the cotter pins with eyes toward the pole.
 - f. Hump back cotters to have ends spread to a minimum opening of 45 DEG.
 - g. Straight cotters to have ends spread and turned back to an opening of 180 DEG.
 - h. Ball hooks for horizontal strings to be installed so that open end of hook faces up.
 - i. Tighten "U" bolts of suspension and dead end clamps to torques recommended by clamp manufacturer, using suitable torquing equipment.
 - j. Tighten all other bolted fittings so that nuts are drawn tight so as to obtain full strength of fitting.
 - k. All fasteners to be installed with appropriate locking devices.
3. Connections:
- a. Follow exactly the recommendations of connector manufacturer for the type of materials being connected (including installation, bolting hardware, joint compound, etc.).
 - b. When connecting different material, use connectors which have no galvanic action.
 - c. Tighten all nuts to required torques using suitable torquing equipment.
 - d. Compression dies to be as recommended by manufacturer.
 - e. Tape all connections to medium voltage spacer cable, except where specified otherwise (use materials and procedures recommended by cable manufacturer).
4. Splicing:
- a. Use personnel experienced and competent in making splices.
 - b. Splices not permitted:
 - 1) Within 50 FT of any structure.
 - 2) Over important highway, railroad, river or other utility line crossing (or in adjacent span).
 - 3) In span where conductor is deadended.
 - c. Minimum distance between splices: 1000 FT.
 - d. For medium voltage spacer cable:
 - 1) Stager splices in adjacent conductors (at least 12 IN between ends of splices).
 - 2) Splices to be at least 18 IN from spacer or insulator.
 - 3) Tape all splices (use materials and procedures recommended by cable manufacturer).
5. Repair sleeves:
- a. Approved for use only if:
 - 1) No damage to steel strands.
 - 2) Not more than 1/3 of the outer strands are damaged over a length of not more than 4 IN.
 - 3) Not more than two strands in the outer layer are broken, and the cross sectional area of any other damaged strands is not reduced by more than 25%.
 - 4) There is no other repair sleeve, conductor splice or conductor deadend in the span.
6. Formed ties:
- a. Follow manufacturer's recommendations.
 - b. Install at supports as shown in the Drawings.
 - c. Do not use any tie a second time.
7. Tie wires:
- a. #6 soft drawn copper tie on #2 copper and smaller.

- b. #4 soft drawn copper tie on #1 copper and larger.
 - c. #6 strong aluminum alloy tie on 1/0 ACSR and smaller.
 - d. #4 strong aluminum alloy tie on 2/0 ACSR and larger.
 - e. Primary conductor shall be bare with weatherproofing removed when bare ties are used.
- K. Clearing (if required on Drawings):
- 1. Take all precautions necessary for protection of existing facilities and structures.
 - 2. The Contractor and Owner shall contact the property owner prior to the start of clearing operations.
 - 3. Cut all trees within 6 IN of ground.
 - 4. Cut all underbrush within 2 IN of ground.
 - 5. Use methods which minimize soil disturbance and silting of streams.
 - 6. Do not cut shade trees, ornamental trees or other valuable trees unless directed, in writing, by Owner (trim or top as required to prevent hazard).
 - 7. Clean up brush, limbs, tree trunks, etc., as work progresses.
 - 8. Spray stumps 1/2 IN and larger with approved chemicals (if allowed).
 - a. Follow manufacturer's recommendations.
 - b. Color spray solution with soluble red dye (Oil Red or Red O).
 - c. Do not spray if bark is wet from dew, fog or rain.
 - d. When moisture conditions permit, spray same day of brush or tree removal (in no event longer than 72 HRS thereafter).
 - e. Contractor responsible for any damage caused by overspray and drift.
 - 9. Stump removal:
 - a. At the option of the Owner/Engineer, all stumps 1/2 IN and larger are to be physically removed from the right-of-way area.
 - b. This may be done by chipping or grubbing.
 - c. All areas are to be leveled and black dirt hauled in as needed to fill holes.
 - d. If the area is maintained, such as a lawn, new sod shall be installed.
 - e. Otherwise a grass seed mixture approved by the Owner is to be used.
 - 10. Disposal of vegetation:
 - a. Dispose of limbs, trees and brush by chipping as much as possible and removing the material to satisfaction of Owner.
 - b. Burning at site will not be permitted.
 - c. Cut all marketable tree trunks and branches (over 6 IN in diameter) into commercial lengths of 8 FT or longer and stack in neat piles along edge of right-of-way.
 - 1) Do not locate piles in a location which would interfere with cultivated fields or pasture.
- L. Phasing:
- 1. Be responsible for insuring that the phasing of the new system is correct.
- M. Clearances:
- 1. All clearances must meet or exceed NFPA 70 and IEEE C2 requirements.
 - a. Verify that all required clearances are obtained.
 - b. Notify Engineer/Owner, in writing, of any locations where clearances cannot be obtained.
 - 2. Record the following measurements (and temperature at time of each measurement) and furnish copy to Owner.
 - a. Crossings of all other utility lines (measure clearance to ground).
 - b. Any locations where required clearances cannot be obtained.
 - c. Any other locations requested by Engineer.

APPENDICES ARE MENTIONED IN THIS SPECIFICATION SECTION

ATTACH IF APPLICABLE

END OF SECTION

SECTION 26 08 00
APPARATUS INSPECTION AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Acceptance Testing

1.2 QUALITY ASSURANCE

- A. Qualifications
 - 1. Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.
 - a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.
 - b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA (Level III) or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.3 SUBMITTALS

- A. Acceptance Tests and Inspections Reports
 - 1. Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.
 - 2. Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

- A. Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization.

3.2 SYSTEM ACCEPTANCE

- A. Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACE EQUIPMENT IN SERVICE

- A. A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

END OF SECTION

SECTION 31 10 00 SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Site clearing Work, including:
 - a. General provisions for site clearing Work.
 - b. Preparation for site clearing Work.
 - c. Clearing and grubbing.
 - d. Tree protection, selective removals, and selective trimming.
 - e. Disposal and cleaning.
 - f. Stripping and stockpiling of topsoil.
- B. Related Requirements: Include but are not necessarily limited to:
 - 1. Section 31 23 00 - Earthwork.

1.2 REFERENCES

- A. Terminology:
 - 1. Terms indicated below are not defined terms indicated with initial capital letters but, when used in this Section, have the meanings indicated below:
 - a. “Arborist” means Subcontractor retained to perform Work requiring a specialist in trees, shrubs, brush, other vegetation of the types existing at the Site, and possessing not less than the required qualifications indicated in this Section.
 - b. “Clearing and grubbing” means removing and disposing of all: (1) trees, brush, and other vegetation, logs, and similar items (“clearing”); and (2) stumps, roots, logs, rubbish, and debris on or in the soil (“grubbing”) after Clearing. Clearing and grubbing includes grinding and removing of stumps. When clearing and grubbing, topsoil stripping and stockpiling, and required demolition Work are complete, the Site will be ready for grading and other new construction.
 - c. “Demolition” means removal, whether in whole or in part, of existing human-made construction, such as removal of buildings, structures, and building systems; site work (such as pavement, curbs, sidewalks, gutters) and the like; Underground Facilities; and other existing construction.
 - d. “Selective removal” means removal of specific trees, shrubs, brush, and other vegetation, whether as shown or indicated in the Contract Documents or as directed at the Site by Engineer.
 - e. “Selective trimming” means removal of selected parts of trees, shrubs, brush, and other vegetation, performed by arborist, for the purpose of either: (1) allowing installation of new construction adjacent to or through the tree, shrub, brush, or vegetation, or (2) removing damaged or unhealthy growth, to allow balance of the subject tree, shrub, brush, or vegetation to continue normal, healthy growth.
 - f. “Site clearing” means all the Work required by this Section and related Drawings.
 - g. “Topsoil” means existing material at the Site, visible after clearing and grubbing, to be stripped, when such material is friable, clay loam, surface soil present in depth of not less than four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material. Topsoil required for planting and landscaping Work in the Specifications of Division 32 may differ from the meaning indicated in this Section.
- B. Reference Standards:
 - 1. ASTM International (ASTM):

- a. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- b. D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
- 2. American National Standards Institute (ANSI):
 - a. A300, Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices.
- 3. International Society of Arboriculture (ISA):
 - a. Container Rootball Shaving.
 - b. Crown Correction.
 - c. Balled and Burlapped Root Correction.
 - d. Container Root Correction.
 - e. High Branched Crown Observation.
 - f. Low Branched Crown Observation.
 - g. Multiple Low Branches Crown Observation.
 - h. Balled and Burlapped Root Observation.
 - i. Container Root Observation - Tree.
 - j. Protection Maintenance.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Clearing Conference:
 - 1. Prior to commencing site clearing Work, actively participate in conference regarding site clearing Work. Date and time of conference will be mutually established by Contractor and Engineer.
 - 2. Location: Conference will be held at the Site in Lead, SD.
 - 3. Participants:
 - a. Required Participants: Contractor's project manager, Contractor's site superintendent, arborist, Engineer, Owners Site Representative.
 - b. Potential Participants: Owner, facility manager (if applicable), site Environment, Safety, & Health Representative.
 - 4. Engineer will chair the conference, prepare and distribute an agenda, and prepare and distribute a record of the conference.
 - 5. Participants shall be prepared to discuss:
 - a. Project requirements and the Contract requirements for site clearing Work.
 - b. Submittals required for site clearing Work.
 - c. Schedule for site clearing Work and availability of resources.
 - d. Locations and types of site clearing Work, with specific attention to areas of selective removals, selective trimming, and notable species. Limits of clearing and grubbing. Proposed locations for stockpiles and temporary storage of cuttings and debris.
 - e. Environmental and other conditions at the Site.
 - f. Growth, vegetation, and existing construction requiring protection.
 - g. Required observations and field quality control for site clearing Work.
 - 6. If additional information affecting site clearing Work subsequently comes to light, reconvene the conference at earliest opportunity.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Arborist:
 - a. Where selective removal, selective trimming, or both are required or necessary, retain the services of, and employ in the Work, accredited arborist, possessing qualifications acceptable to Engineer.
 - b. Arborist shall be skilled, trained, and possess documented experience in successfully protecting, trimming, and restorative care of trees and shrubs of the types necessary for the Work.

- c. Certification: Arborist shall be certified by either International Society of Arboriculture (ISA) or American Society of Consulting Arborists (ASCA).
- d. Arborist shall use in selective removal and selective trimming Work only workers with specific skill and successful experience in this type of Work required. Such workers shall work under the direct, personal supervision of arborist.
- e. Submit to Engineer names, employer(s), certifications, other relevant qualifications and record of relevant experience, as indicated below, for not less than [three] successful projects involving same species of trees, shrubs, and vegetation as involved in the site clearing Work:
 - 1) Names and telephone numbers of site owners, architects or engineers responsible for projects.
 - 2) Approximate contract price of the selective removal and selective trimming of trees, shrubs, and vegetation.
 - 3) Approximate time of year work was performed on each referenced project.
 - 4) Approximate quantity and types of selective removal and selective trimming of performed.
 - 5) General indication of species of trees, shrubs, and vegetation involved.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Limits of Site Clearing Work: When limits of site clearing Work are not expressly shown on the Drawings, or where Contractor proposes alternative limits of site clearing Work, submit drawings, developed from the Drawings, clearly indicating proposed limits of site clearing Work, with dimensions indicated where appropriate.
 - b. Where proposed limits of clearing and grubbing, selective removals, and topsoil stripping are not identical with each other, clearly and expressly indicate limits of each on the Shop Drawings. .
- B. Informational Submittals: Submit the following:
 - 1. Permits and Approvals:
 - a. Submit copy of each permit required and obtained for site clearing Work, issued by authority having jurisdiction.
 - b. Where Owner's permission or approval is required for selected site clearing activities, submit copy of Owner's written permission or approval for such activity.
 - c. When approval of owner of property (other than Owner) is required for selected site clearing activity, submit to Engineer written copy of such approval.
 - 2. Certificates:
 - a. Arborist's certification that trees and shrubs shown or indicated to remain were protected during the site clearing Work in accordance with the Contract Documents.
 - b. Where trees or shrubs (shown or indicated to remain) were damaged during site clearing Work, submit arborist's certification that such trees and shrubs were promptly and properly treated or, where successful treatment was not feasible, were replaced.
 - 3. Qualifications Statements:
 - a. Arborist qualifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Tree Wound Dressing:
 - 1. Provide tree wound dressing, waterproof, adhesive and elastic with an antiseptic, free from kerosene, coal tar, creosote, and other material injurious to life of tree or other plant.
- B. Drainage Fill:
 - 1. Selected crushed stone, or crushed or uncrushed gravel, washed.

2. Size 24 (in accordance with ASTM D448), with 90 to 100 percent passing 2.5-inch sieve and not more than 10 percent passing 3/4-inch sieve.
- C. Burlap:
 1. Jute, not less than 7.2 ounces per square yard.
- D. For other materials needed for site clearing Work, such as stone, topsoil, or other, comply with requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 SITE CLEARING – GENERAL

- A. Limits of Site Clearing Work:
 1. Perform site clearing Work for all Work areas unless otherwise shown or indicated in the Contract Documents. Do not perform site clearing Work outside the limits of the areas required for new construction.
- B. General Provisions for Site Clearing:
 1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to perform site clearing Work in accordance with the Contract Documents.
 2. Perform site clearing Work to avoid creating nuisances, pollution, and preventable adverse effects on the environment.
 3. Comply with any applicable Section 01 standards
 4. Excavation required for site clearing shall comply with Section 31 23 00 - Earthwork.
 5. Requirements of Authorities Having Jurisdiction:
 - a. Perform site clearing Work in accordance with Laws and Regulations.
 - b. Obtain, pay for, and comply with permits required for site clearing Work. Obtain from authorities having jurisdiction and furnish copy of each permit as a Submittal.
 6. Traffic Control:
 - a. Establish such controls prior to and maintain in place throughout site clearing Work that has potential to affect traffic.
 7. Site clearing Work shall comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article, unless the Contract Documents indicate more-stringent requirements.
 8. Demolition Work is indicated in Section 02 41 00 - Deconstruction, including removal of site improvements and Underground Facilities.

3.2 PREPARATION

- A. Permits and Approvals:
 1. Do not commence site clearing Work until necessary permits and approvals are obtained and copies furnished to Engineer as Submittals.
- B. Delineation of Limits of Site Clearing Work Areas:
 1. Locate and clearly flag at the Site:
 - a. Limits of site clearing Work.
 - b. Trees, shrubs, vegetation, and other materials to remain within limits of site clearing Work.
 - c. Trees, shrubs, and other vegetation to be selectively trimmed.
 - d. Trees, shrubs, and vegetation to be selectively removed.
 - e. Salvageable trees, shrubs, and vegetation (to be relocated) within limits of site clearing Work.
 2. Flagging:
 - a. Flagging shall be high-visibility type. Where necessary, provide lath or stakes driven into the ground, with flagging, to clearly delineate limits.
 - b. Provide different-colored flagging for each type of delineation required by this Article.

- c. Promptly replace lost, moved, or destroyed flagging until Engineer concurs that flagging is no longer needed.
- 3. Review with Engineer:
 - a. Before starting site clearing Work, other than flagging, review at the Site with Engineer.
 - b. Make corrections as necessary.
 - c. Review all trees, [12]-inch diameter (measured one foot above ground) and larger, to be removed or selectively trimmed.
 - d. Review with Engineer at the Site trees and shrubs to be selectively trimmed, to reach mutual agreement on extent of selective trimming required.
- C. Protection: Establish protection of trees, shrubs, and vegetation to remain, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming", and other applicable provisions of the Contract Documents.
- D. Temporary Erosion and Sediment Controls:
 - 1. Provide applicable temporary erosion and sediment controls before commencing clearing and grubbing and topsoil stripping Work.
 - 2. Comply with temporary erosion and sediment control requirements of Section 01 57 05 - Temporary Controls.
 - 3. Continue providing temporary erosion and sediment controls as clearing and grubbing and topsoil stripping and stockpiling Work progresses into previously uncleared, ungrubbed areas of the Site...

3.3 CLEARING AND GRUBBING

- A. Clearing and Grubbing – General:
 - 1. Remove and dispose of all materials constituting clearing and grubbing Work within limits shown and indicated in the Contract Documents.
 - 2. After grubbing Work is complete, properly fill holes resulting from grubbing before commencing site grading Work.
- B. Trees and Shrubs Improperly Destroyed or Damaged:
 - 1. Refer to this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".
- C. Trees and Shrubs to Remain:
 - 1. Trees and shrubs to remain shall be protected, and trimmed where necessary or required, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".

3.4 TREE PROTECTION, SELECTIVE REMOVALS, AND SELECTIVE TRIMMING

- A. General Provisions for Tree Protection, Selective Removals, and Selective Trimming:
 - 1. Provide temporary fencing, barricades, or guarding measures, as recommended by arborist, outside drip line of trees and shrubs to remain.
 - 2. Protect root systems from damage caused by noxious materials, storm water runoff, site clearing, planting and landscaping, other Work, and storage of materials and equipment. Protect root systems from flooding, erosion, and excessive wetting resulting from dewatering of excavations, drainage of tanks, and other construction activities.
 - 3. Fires are not allowed under or adjacent to trees, shrubs, and other vegetation to remain.
 - 4. Do not store matter resulting from site clearing or demolition, topsoil, or other excavated material within drip line of trees and shrubs to remain. Vehicles are not allowed within drip line. Restrict foot, vehicle and equipment traffic to prevent compaction of soil over root systems. Where such activities are unavoidable, and only as acceptable to Engineer, provide temporary, continuous, heavy-duty wood planking effectively fastened together and capable of distributing loads from such activities. Temporary planking shall be underlaid by layer of filter fabric covered with two-inch layer of gravel.

5. Cut branches and roots, when necessary, with sharp pruning instruments; do not break or chop. Fully paint cuts 1/2-inch and larger in size with tree wound dressing.
- B. Excavation and Protection of Trees and Shrubs:
1. Excavate within drip line of trees only where shown.
 2. Where trenching for utilities is required within drip line, tunnel under or around main lateral feeder roots by drilling, auger boring, pipe jacking, or digging by hand under supervision of arborist. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of the Work.
 3. Where excavation for the Work is required within drip line of trees or shrubs, hand excavate to minimize damage to root systems. Perform excavation under supervision of arborist. Provide temporary shoring or other protective support systems at excavations, to minimize sloping and benching of excavations. Use narrow tine spading forks and comb excavated material to expose roots.
 4. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of construction and relocation is not practical, cut roots approximately three inches back from construction.
 5. Do not allow exposed roots to dry out before permanent backfill is provided; provide temporary earth cover. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.
- C. Grade Adjustments and Tree Protection:
1. Maintain existing grade within drip line of trees, unless otherwise shown or indicated.
 2. Lowering of Preconstruction Grade:
 - a. Where required finish grade is below preconstruction grade around trees and shrubs, grade beyond drip line. Maintain preconstruction grade within drip line of trees and shrubs.
 - b. Prune tree and shrub roots exposed during grade lowering, or provide permanent protections as recommended by arborist. Do not cut main or lateral roots or tap-roots; cut only smaller roots.
 - c. Compensate for loss of roots and prune branches to stimulate root growth.
 - d. Provide extended service through completion of the Contract correction period as recommended by arborist.
 3. Minor Fills:
 - a. Where preconstruction grade is six inches or less below elevation of finish grade shown, fill with topsoil complying with quality requirements of Specifications for finish grading and landscaping.
 - b. Place in single layer and do not compact.
 - c. Hand-grade to required finish elevations.
 4. Moderate Fills:
 - a. Where preconstruction grade is more than six inches, but less than 16 inches, below finish grade elevation, provide layer of drainage fill and filter fabric on preconstruction grade prior to placing topsoil that complies with quality requirements of Specifications on finish grading and landscaping.
 - b. Carefully place drainage fill against trunk of tree or shrub approximately two inches above elevation of finish grade and extend not less than 1.5 feet from tree or shrub trunk on all sides.
 - c. Provide filter fabric with edges overlapping by 6 inches, minimum.
 - d. Place fill layer of topsoil to finish grade elevation.
 - e. Do not compact stone, gravel or topsoil layers. Hand-grade to required finish elevations.
 5. Deep Fills:
 - a. Provide an open dry circular well of durable, unmortared stone, located not less than two feet s from trunk of associated tree or shrub.

- b. To facilitate proper drainage, provide eight to 10 continuous runs of four-inch drain tiles horizontally on the preconstruction ground surface under the complete spread of branches in radial pattern around the tree or shrub.
 - c. Slope drain tiles away from tree or shrub.
 - d. Provide drainage fill on preconstruction ground surface in depth of two inches under and six inches over drain tiles.
 - e. Provide filter fabric over entire top surface of drainage fill.
 - f. Provide eight to 10 drainage tiles, each four-inch diameter, vertically in radial pattern around tree or shrub, located five feet from trunk of tree or shrub. Extend vertical drainage tiles from the filter fabric layer above the horizontal drainage tiles to postconstruction finished grade
 - g. Hold drainage tiles in place with drainage fill.
 - h. Hand-grade to required finish grade elevation.
- D. Tree and Shrub Pruning (Selective Trimming):
 - 1. Perform pruning and selective trimming under the supervision of arborist.
 - 2. Remove branches from trees and shrubs to remain only after Engineer's concurrence, only to extent necessary to clear location of permanent construction, using branch removal methods in accordance with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 - 3. Extend pruning operation to restore natural shape of entire tree or shrub where pruning is approved by Engineer and as recommended by arborist.
 - 4. Prune branches to balance loss to root system caused by damage or cutting of root system.
 - 5. Chip branches removed from trees and shrubs. Stockpile and spread chips as directed by Engineer, with arborist's recommendation.
- E. Selective Trimming:
 - 1. In addition to pruning (as required above), perform other selective trimming under direction of arborist.
 - 2. Comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 - 3. Where shown or indicated, and as directed by Engineer with arborist's recommendation, carefully remove larger branches, when necessary, using appropriate methods.
 - 4. Repair cut branches in accordance with this Section.
 - 5. During selective trimming, avoid damaging healthy (to remain) elements of trees and shrubs.
 - 6. Dispose of trimmings as indicated in this Section's "Disposal and Cleaning" Article.
- F. Selective Removals:
 - 1. Perform selective removals under direction of arborist.
 - 2. Comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 - 3. Fully remove trees and shrubs shown or indicated for selective removal.
 - 4. Remove stumps to not less than one foot below preconstruction ground surface.
 - 5. During selective removals, avoid damaging adjacent trees and shrubs to remain, and other property.
 - 6. Remove larger branches before cutting the trunk of tree or shrub being selectively removed.
 - 7. Dispose of trees and shrubs selectively removed as indicated in this Section's "Disposal and Cleaning" Article.
- G. Repair and Replacement of Trees and Shrubs:
 - 1. Perform tree and shrub repair under direction of arborist.
 - 2. Cavity Repair:
 - a. Remove decayed areas to depth that exposes healthy tissue.
 - b. Shape cavities to provide drainage.
 - c. Paint inside of cavity with antiseptic tree wound dressing material.
 - d. Do not fill cavities.

- e. When cavity's cross-section exceeds 60 percent of cross-section of tree or shrub branch, selectively trim subject branch. When cavity's cross-section exceeds 60 percent of cross-section of trunk of tree or shrub, remove tree or shrub upon Engineer's authorization. Engineer will consider arborist's recommendation. Comply with this Section's requirements for selective trimming and selective removals.
3. Repair trees and shrubs damaged by construction operations, or selectively trimmed, within 24 hours of occurrence of such damage or selective trimming. Treat damaged trunks, branches, and roots according to written instructions of arborist, in accordance with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
4. Remove and replace trees and shrubs that are (1) dead or destroyed due to construction operations, or (2) damaged beyond reasonable hope of recovery (as determined by arborist) following repairs, or (3) damaged and determined by arborist to be incapable of resuming normal growth pattern after repairs.,
5. Obtain opinion from arborist regarding whether damaged trees, shrubs, and other vegetation is repairable with reasonable chance of success. Submit arborist's certification required in this Section's "Submittals" Article.
6. For each tree or shrub to remain but is destroyed or damaged (beyond repair) by Contractor:
 - a. For trees [8] inches or more in diameter (measured one foot above preconstruction ground surface), provide two replacements of the same species. Each replacement shall be four inches diameter (measured one foot above top of root ball).
 - b. For trees smaller than [eight] inches diameter, and for shrubs, provide one replacement for each, of same species. Replacements shall be equal in size to original, up to maximum of four inches (measured one foot above root ball).
 - c. Provide replacement at locations at the Site as directed by Engineer.
 - d. Provide replacements in accordance with the Contract Documents, including Specifications on planting and landscaping.

3.5 DISPOSAL AND CLEANING

- A. Disposal – General:
 1. Dispose of matter resulting from clearing and grubbing, selective removals, and selective trimming, at appropriate offsite location, unless otherwise expressly allowed by the Contract Documents or mutual agreement of Owner and Contractor.
 2. Do not use cleared, grubbed, or trimmed material as fill, backfill, or in embankments.
 3. Dispose of cleared, grubbed, and trimmed material, and other materials, rubbish, and debris, in accordance with Laws and Regulations.
 4. Pay all costs associated with transporting and disposing of materials and debris resulting from site clearing Work.
 5. Cleared lumber and trimmings from trees are Contractor's property and, at Contractor's option, may be sold or salvaged offsite.
- B. Cleaning:
 1. Perform progress cleaning and other cleaning Work, and disposal of resulting materials and debris.
- C. Burning:
 1. Burning of trees, shrubs, brush, other vegetation, and other materials at, or adjacent to, the Site, whether in-place or cut, is prohibited unless: (a) burning is not prohibited by Laws or Regulations, and (b) required permits, if any, are obtained by Contractor from authorities having jurisdiction and are furnished to Engineer as Submittals; and (c) written approval of Owner is obtained and furnished to Engineer as a Submittal; and (d) when burning will be performed on lands at the Site not owned by Owner, obtain and submit to Engineer as Submittals written approval of owners of such properties.
 2. Before burning, alert local fire department (both orally and in writing) not less than 72 hours before burning, and provide at location of burning appropriate emergency materials, tools, and equipment to contain and extinguish fires. Use such items and furnish necessary labor to prevent fire from burning other than intended trees, shrubs, brush, and vegetation.

3. If burning is allowed, exercise appropriate care and judgement. Do not perform burning in high wind conditions. Do not perform burning when areas adjacent to burning are of dryness that will foster wildfires.
4. Promptly and fully extinguish fires before they burn unintended areas or materials, and when burning is completed.
5. Dispose of ashes and burned materials off-site at appropriate location.

3.6 TOPSOIL STRIPPING AND STOCKPILING

- A. Stripping:
 1. Before commencing topsoil stripping:
 - a. Perform clearing and grubbing and selective removals.
 - b. Remove grass and other vegetation that may remain following clearing and grubbing.
 - c. Provide necessary and required temporary erosion and sediment controls.
 2. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil and other objectionable material. Remove heavy growths of grass and vegetation and material below topsoil.
 3. Before stockpiling, separate objectionable material from topsoil.
 4. Do not strip topsoil from within drip line of trees and shrubs to remain as part of the completed Project.
- B. Stockpiling:
 1. Construct and maintain topsoil stockpiles at locations agreed to with Owner.
- C. Reuse of Stripped Topsoil:
 1. Reuse in the finish grading and landscaping Work topsoil that complies with the Contract Documents for such Work.
 2. Where topsoil stripped from the Site does not comply with the Contract Documents relative to quality required for use in finish grading and landscaping Work, provide appropriate soil amendment material, properly and fully mixed into topsoil stripped from the Site, so that amended material complies with quality requirements for topsoil required for finish grading and landscaping Work.
- D. Disposal of Excess Topsoil:
 1. Topsoil in excess of quantity required for finished Project becomes Contractor's property when Engineer indicates finish grading and landscaping Work is complete. Properly dispose of excess topsoil offsite. Contractor may sell excess topsoil at offsite location.

END OF SECTION

SECTION 31 23 00

EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Earthwork - excavation, backfilling, grading, compaction, disposal of waste and surplus materials, placing crushed stone, construction of berms, sheeting, bracing, dewatering and other Earthwork related work.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 31 23 33 – Trenching, Backfilling, and Compacting for Utilities

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³).
 - c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT³(2,700 kN-M/M³)).
 - d. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - e. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
 - f. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - g. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - h. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 2. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR Part 1926.650, Safety and Health Regulations for Construction - Excavations, referred to herein as OSHA Standards.

1.3 DEFINITIONS

- A. Excavation:
 - 1. Consists of removal of material encountered to subgrade elevations required or indicated.
 - 2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.
- B. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.
- C. Unauthorized Excavation:
 - 1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
 - a. Unauthorized excavation, as well as associated remedial work as directed by Engineer or Geotechnical Engineer, shall be at Contractor's expense.
 - 2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 2. Certifications.
- B. Samples:
 - 1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.
 - 2. Test reports.

1.5 PROJECT CONDITIONS

- A. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.
- B. Dispose of waste materials, legally, off site.
 - 1. Burning, as a means of waste disposal, is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill and Backfill:
 - 1. Selected material approved by Geotechnical Engineer from site excavation or from off site borrow.
 - 2. Non-Structural Fill:
 - a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
 - b. Liquid limit: Less than 45.
 - c. Maximum plasticity index: 20.
- B. Flowable Fill

PART 3 - EXECUTION

3.1 PROTECTION

- A. Erosion Control:
 - 1. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
 - 2. Conduct work to minimize erosion of site. Remove eroded material washed off site.
 - a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.
- B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
 - 1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
 - 2. Protect and maintain benchmarks, monuments or other established reference points and property corners.
 - a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
 - 3. Verify location of utilities.
 - a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
 - b. Secure and examine local utility records for location data.
 - c. Take necessary precautions to protect existing utilities from damage due to any construction activity.

- 1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
- 2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
- 3) Obtain Owner's approval prior to disconnecting any utility service.
- d. Repair damages to utility items at own expense.
- e. In case of damage, notify Engineer at once so required protective measures may be taken.
4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
 - a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
 - c. All repairs to be made and paid for by Contractor.
5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.

3.2 SITE EXCAVATION AND GRADING

- A. The site excavation and grading work includes the offsite disposition of all material:
 1. That exceed quantities required for earthwork on the project.
 2. That the Geotechnical engineer classifies as unclassified excavation.
 3. That the Geotechnical engineer classifies as unacceptable.
 4. That the Geotechnical engineer classifies as potentially contaminated.
- B. Excavation and Grading:
 1. Perform as required by the Contract Drawings.
 2. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
 - a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
 - b. Perform other layout work required.
 - c. Replace property corner markers to original location if disturbed or destroyed.
 3. Preparation of ground surface for embankments or fills:
 - a. Before fill is started, scarify to a minimum depth of 6 IN in all proposed embankment and fill areas.
 - b. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface.
 4. Protection of finish grade:
 - a. During construction, shape and drain embankment and excavations.
 - b. Maintain ditches and drains to provide drainage at all times.
 - c. Protect graded areas against action of elements prior to acceptance of work.
 - d. Reestablish grade where settlement or erosion occurs.
- C. Borrow:
 1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
 2. Include cost of all borrow material in original proposal.
 3. Fill material to be approved by Geotechnical Engineer prior to placement.
- D. Construct embankments and fills as required by the Contract Drawings:

1. Construct embankments and fills at locations and to lines of grade indicated.
 - a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
2. Provide approved fill material which is free from roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
 - a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.
 - b. Do not place material in layers greater than 8 IN loose thickness.
 - c. Place layers horizontally and compact each layer prior to placing additional fill.
3. Compact soils as required to obtain specified density. Selection of appropriate equipment is the Contractor's responsibility.
 - a. In general, compact cohesive soils by sheep'sfoot, and granular soils by pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
 - b. Control moisture for each layer necessary to meet requirements of compaction.

3.3 USE OF EXPLOSIVES

- A. Blasting with any type of explosive is prohibited.

3.4 COMPACTION DENSITY REQUIREMENTS

- A. Obtain approval from Geotechnical Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.
- B. Provide dewatering system necessary to successfully complete compaction and construction requirements.
- C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Geotechnical Engineer.
- D. Stabilize subgrade with well graded granular materials as directed by Geotechnical Engineer.
- E. Assure by results of testing that compaction densities comply with the following requirements:
 1. Sitework:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under Paved Areas, Sidewalks and Piping:		
Cohesive soils	95% per ASTM D698	-2 to +3% of optimum
Cohesionless soils	75% relative density per ASTM D4253 and ASTM D4254	
Unpaved Areas:		
Cohesive soils	90% of ASTM D698	-2 to +3% of optimum
Cohesionless soils	65% relative density per ASTM D4253 and ASTM D4254	

2. Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Inside of structures under foundations, under equipment support pads, under slabs-on-grade and scarified existing subgrade under fill material	98% per ASTM D698	-2 to +3% of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	92% per ASTM D698	-2 to +3% of optimum

3. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside structures under equipment support foundations	98% per ASTM D698	-2 to +3% of optimum
Under void	85% per ASTM D1557	-2 to +3% of optimum
Granular fill under base slabs with pressure relief valves	75% relative density per ASTM D4253 and ASTM D4254 or 98% of ASTM D698	
Granular fill under building floor slabs-on-grade	60% relative density per ASTM D4253 and ASTM D4254	

3.5 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:

1. In general, work includes, but is not necessarily limited to, excavation for structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
2. Obtain fill and backfill material necessary to produce grades required.
 - a. Materials and source to be approved by Geotechnical Engineer.
 - b. Excavated material approved by Geotechnical Engineer may also be used for fill and backfill.
3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:

1. General:
 - a. Do not commence excavation for foundations for structures until Geotechnical Engineer approves:
 - 1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
 - 2) Density and moisture content of site area compacted fill material meets requirements of specifications.
 - 3) Site surcharge or mass fill material can be removed from entire construction site or portion thereof.
 - 4) Surcharge or mass fill material has been removed from construction area or portions thereof.
 - b. Engineer grants approval to begin excavations.
2. Dimensions:
 - a. Excavate to elevations and dimensions indicated or specified.
 - b. Allow additional space as required for construction operations and inspection of foundations.
 - c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.

- d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- 3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.
 - a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Geotechnical Engineer.
 - b. Remove unsuitable subgrade soils located below foundations. The bottom of the overexcavation shall be located outside the exterior limits of foundations around the perimeter of structure the following horizontal distance, whichever is greater:
 - 1) Distance equal to depth of overexcavation below bottom of foundations.
 - 2) 5 FT.
 - 3) As directed by Geotechnical Engineer.
 - c. When excavation has reached required subgrade elevations, notify Geotechnical Engineer, who will make an inspection of conditions.
 - 1) If Geotechnical Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide Subgrade Stabilization as specified herein.
- C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:
 - 1. General:
 - a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Geotechnical Engineer and scarified to a depth of 6 IN and compacted to density specified herein.
 - b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2%.
 - c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Geotechnical Engineer as being free of undesirable material and compacted to specified density.
 - 2. Obtain approval of fill and backfill material and source from Geotechnical Engineer prior to placing the material.
 - 3. Granular fill under floor slabs-on-grade: Place all floor slabs-on-grade on a minimum of 6 IN of granular fill unless otherwise indicated.
 - 4. Fill and backfill placement:
 - a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Geotechnical Engineer.
 - b. Place fill and backfill material in 12 IN lifts.
 - c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
 - d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
 - 2) Contractor is responsible for method of compaction so as not to damage wall.
 - e. Use hand operated equipment for filling and backfilling next to walls.
 - f. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
 - g. Use vibratory equipment to compact granular material; do not use water.
 - 5. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.
- D. Filling and Backfilling Outside of Structures:
 - 1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.

2. Provide material as approved by Geotechnical Engineer for filling and backfilling outside of structures.
3. Fill and backfill placement:
 - a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Geotechnical Engineer.
 - b. Place fill and backfill material to maximum allowable lift thickness indicated in Paragraph 3.5, C, 5, b of this Section.
 - c. Compact material with equipment of proper type and size to obtain density specified.
 - d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
 - 2) Contractor is responsible for method of compaction so as not to damage wall.
 - e. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.
 - f. Do not place fill or backfill material when temperature is less than 40 DEGF and when subgrade to receive material is frozen, wet, loose, or soft.
 - g. Use vibratory equipment for compacting granular material; do not use water.
4. Backfilling against walls:
 - a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.
 - b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
 - c. Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.
 - 1) See Contract Drawings for specific exceptions.
 - d. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.
- E. Backfilling Outside of Structures Under Piping or Paving:
 1. When backfilling outside of structures requires placing backfill material under piping or paving, the material shall be placed from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in this Specification Section.
 2. This compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.
 3. Provide special compacted bedding or compacted subgrade material under piping or paving as required by other Specification Sections for the Project.

3.6 FIELD QUALITY CONTROL

- A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA Standards, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.
- B. Responsibilities of Special Inspector:
 1. Review proposed materials for fill and backfill around structures.
 2. All testing, observation and work indicated as being performed by the Geotechnical Engineer in Article 3.5 of this Specification Section .
 3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.

5. Extent of compaction testing will be as necessary to assure compliance with specifications.
 6. Prepare and submit inspection and test reports to Engineer.
 - a. Coordinate such work with other Special Inspectors.
 7. Test reports to include the following:
 - a. Report and certification of aggregate fill and drainage fill.
 - b. Test reports on borrow material.
 - c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
 - d. Field reports; in-place soil density and moisture tests.
 - e. One optimum moisture-maximum density curve for each type of soil encountered.
 - f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 - g. Other documentation necessary for Geotechnical Engineer to approve earthwork.
 - h. Assist Engineer to determine corrective measures necessary for defective work.
- C. Responsibilities of Testing Agency for Site Excavation and Grading:
1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.5 of this Specification Section.
 2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 3. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
 4. Extent of compaction testing will be as necessary to assure compliance with specifications.

END OF SECTION

SECTION 31 23 10

EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Earthwork - excavation, backfilling, compaction, disposal of waste and surplus materials, placing structural fill, placing crushed stone, sheeting, bracing, dewatering and other Earthwork related work.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. C33, Standard Specification for Concrete Aggregates.
 - b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/CUFT).
 - c. D1241, Standard Specification for Material for Soil-Aggregate Subbase, Base, and Surface Courses.
 - d. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/CUFT(2,700 kN-M/M)).
 - e. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - f. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
 - g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - h. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - i. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 2. American Association of State Highway and Transportation Officials (AASHTO)
 - a. M 43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
 - b. M 57, Standard Specification for Materials for Embankment and Subgrades.
 - c. M 147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
- B. Federal Regulations:
 - 1. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR Part 1926.650, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

1.3 DEFINITIONS

- A. Excavation:
 - 1. Consists of removal of material encountered to subgrade elevations required or indicated.
 - 2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.
- B. Foundations: Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.

- C. Geotechnical Engineer: Independent geotechnical specialist providing field quality control for the project.
- D. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.
- E. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.
- F. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.
- G. Unauthorized Excavation:
 - 1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
 - a. Unauthorized excavation, as well as associated remedial work as directed by Engineer or Geotechnical Engineer, shall be at Contractor's expense.
 - 2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Acknowledgement that products submitted meet requirements of standards referenced.
 - 2. Manufacturer's installation instructions.
 - 3. Certifications.
 - 4. Test reports.
 - a. Report and certification of aggregate fill and drainage fill.
 - b. Test reports on borrow material.
- B. Samples:
 - 1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.
 - 2. Submit samples and source of fill and backfill materials proposed for use.
 - 3. Submit samples and source of borrow materials proposed for use.

1.5 PROJECT CONDITIONS

- A. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.
- B. Dispose of waste materials, legally, off site.
 - 1. Burning, as a means of waste disposal, is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill and Backfill:
 - 1. Selected material approved by Geotechnical Engineer [from site excavation or] from off site borrow.
 - 2. Non-Structural Fill:
 - a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
 - b. Liquid limit: Less than 45.
 - c. Maximum plasticity index: 20.
- B. Granular Fill Under Building Floor Slabs-On-Grade, Electrical Equipment Pads, Manholes and Handholes:
 - 1. Clean, granular material.
 - 2. Less than 5% fines passing the No. 200 sieve.

3. ASTM C33/AASHTO M43 gradation size No. 89, 3/8 IN to No. 4 or other material acceptable to Geotechnical Engineer.
- C. Granular Fill Under, Electrical Equipment Pads, Manholes and Handholes:
 1. Clean, Granular material.
 2. Less than 5% fines passing the No. 200 sieve.
 3. ASTM D1241/AASHTO M147 Grading "B" or other material acceptable to Geotechnical Engineer.
- D. Flowable Fill

PART 3 - EXECUTION

3.1 PROTECTION

- A. Erosion Control:
 1. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
 2. Conduct work to minimize erosion of site. Remove eroded material washed off site.
 - a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.
- B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
 1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
 2. Protect and maintain bench marks, monuments or other established reference points and property corners.
 - a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
 3. Verify location of utilities.
 - a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
 - b. Secure and examine local utility records for location data.
 - c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
 - 1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
 - 2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
 - 3) Obtain Owner's approval prior to disconnecting any utility service.
 - d. Repair damages to utility items at own expense.
 - e. In case of damage, notify Engineer at once so required protective measures may be taken.
 4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
 - a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
 - c. All repairs to be made and paid for by Contractor.
 5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
 6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
 7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.

3.2 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

- A. General:
 - 1. In general, work includes, but is not necessarily limited to, excavation for structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
 - 2. Obtain fill and backfill material necessary to produce grades required.
 - a. Materials and source to be approved by Geotechnical Engineer.
 - b. Excavated material approved by Geotechnical Engineer may also be used for fill and backfill.
 - 3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.
- B. Excavation Requirements for Structures:
 - 1. General:
 - a. Do not commence excavation for foundations for structures until Geotechnical Engineer approves:
 - 1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
 - 2) Density and moisture content of site area compacted fill material meets requirements of specifications.
 - 3) Site surcharge or mass fill material can be removed from entire construction site or portion thereof.
 - 4) Surcharge or mass fill material has been removed from construction area or portions thereof.
 - b. Engineer grants approval to begin excavations.
 - 2. Dimensions:
 - a. Excavate to elevations and dimensions indicated or specified.
 - b. Allow additional space as required for construction operations and inspection of foundations.
 - c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
 - d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
 - 3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.
 - a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Geotechnical Engineer.
 - b. Remove unsuitable subgrade soils located below foundations. The bottom of the overexcavation shall be located outside the exterior limits of foundations around the perimeter of structure the following horizontal distance, whichever is greater:
 - 1) Distance equal to depth of overexcavation below bottom of foundations.
 - 2) [5] FT.
 - 3) As directed by Geotechnical Engineer.
 - c. When excavation has reached required subgrade elevations, notify Geotechnical Engineer, who will make an inspection of conditions.
 - 1) If Geotechnical Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide Subgrade Stabilization as specified herein.
 - 4. Level off bottoms of excavations to receive foundations, floor slabs, equipment support pads, or compacted fill.
 - a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.

- b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 6 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
- c. Do not carry excavations lower than shown for foundations except as directed by Geotechnical Engineer or Engineer.
- d. If any part of excavations is carried below required depth without authorization, notify Engineer and correct unauthorized excavation as directed. Corrections may include:
 - 1) Under soil supported footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
 - a) Concrete fill may be used to bring elevations to proper position.
 - 2) In locations other than those above, including slabs on grade and pile supported foundations, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Geotechnical Engineer.
 - 3) No extra compensation will be made to Contractor for correcting unauthorized excavations.
- 5. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
- 6. Notify Geotechnical Engineer and Engineer as soon as excavation is completed in order that subgrades may be inspected.
 - a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings has been inspected and approved by the Geotechnical Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.
 - b. Geotechnical Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
 - c. Place fill material, foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
 - d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
- 7. Subgrade stabilization:
 - a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Geotechnical Engineer.
 - b. Provide compaction density of replacement material as stated in this Specification Section.
 - c. Loose, wet, or soft materials, when approved by Geotechnical Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
 - d. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.
 - e. Remove and replace frozen materials as directed by Geotechnical Engineer.
 - f. Method of stabilization shall be performed as directed by Geotechnical Engineer.
 - g. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Geotechnical Engineer.
- 8. Protection of structures:
 - a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.

- b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
- 9. Shoring:
 - a. Shore, slope, or brace excavations as required to prevent them from collapsing.
 - b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
 - c. Construct shoring that is required to retain water as part of the dewatering system, using non-permeable details such as interlock sealant for sheet piles.
- 10. Drainage:
 - a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
 - b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.
 - c. Provide pumping required to keep excavated spaces clear of water during construction.
 - d. Should any water be encountered in the excavation, notify Engineer and Geotechnical Engineer.
 - e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.
- 11. Frost protection:
 - a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.
 - b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.
 - c. Protect excavation from frost if placing of concrete or fill is delayed.
 - d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Owner.
 - e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DEGF.
- C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:
 - 1. General:
 - a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Geotechnical Engineer and scarified to a depth of 6 IN and compacted to density specified herein.
 - b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2%.
 - c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Geotechnical Engineer as being free of undesirable material and compacted to specified density.
 - 2. Obtain approval of fill and backfill material and source from Geotechnical Engineer prior to placing the material.
 - 3. Granular fill under floor slabs-on-grade: Place all floor slabs-on-grade on a minimum of 6 IN of granular fill unless otherwise indicated.
 - 4. Vapor barrier: Install a continuous vapor barrier under floor slabs-on-grade
 - 5. Fill and backfill placement:
 - a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Geotechnical Engineer.
 - b. Place fill and backfill material in [12] IN lifts.
 - c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.

- d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum.
 - 2) Contractor is responsible for method of compaction so as not to damage walls or buried commodities.
 - e. Use hand operated equipment for filling and backfilling next to walls.
 - f. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
 - g. Use vibratory equipment to compact granular material; do not use water.
 - 6. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.
- D. Filling and Backfilling Outside of Structures.
- 1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.
 - 2. Provide material as approved by Geotechnical Engineer for filling and backfilling outside of structures.
 - 3. Fill and backfill placement:
 - a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Geotechnical Engineer.
 - b. Place fill and backfill material to maximum allowable lift thickness indicated in Paragraph 3.2, C, 5, b of this Section.
 - c. Compact material with equipment of proper type and size to obtain density specified.
 - d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum.
 - 2) Contractor is responsible for method of compaction so as not to damage walls or buried commodities.
 - e. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.
 - f. Do not place fill or backfill material when temperature is less than 40 DEGF and when subgrade to receive material is frozen, wet, loose, or soft.
 - g. Use vibratory equipment for compacting granular material; do not use water.
 - 4. Backfilling against walls:
 - a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.
 - b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
 - c. Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.
 - 1) See Contract Drawings for specific exceptions.
 - d. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.
- E. Backfilling Outside of Structures Under Piping or Paving:
- 1. When backfilling outside of structures requires placing backfill material under piping or paving, the material shall be placed from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in this Specification Section.

2. This compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.
3. Provide special compacted bedding or compacted subgrade material under piping or paving as required by other Specification Sections for the Project.

3.3 USE OF EXPLOSIVES

- A. Blasting with any type of explosive is prohibited.

3.4 COMPACTION DENSITY REQUIREMENTS

- A. Obtain approval from Geotechnical Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.
- B. Provide dewatering system necessary to successfully complete compaction and construction requirements.
- C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Geotechnical Engineer.
- D. Stabilize subgrade with well graded granular materials as directed by Geotechnical Engineer.
- E. Assure by results of testing that compaction densities comply with the following requirements:
 1. Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Inside of structures under foundations, under equipment support pads, under slabs-on-grade and scarified existing subgrade under fill material	[98% per ASTM D698] [95% per ASTM D698]	-2 to +3% of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	[92% per ASTM D698] [90% per ASTM D698]	-2 to +3% of optimum

2. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside structures under equipment support foundations	[98% per ASTM D698] [95% per ASTM D698]	-2 to +3% of optimum
Under void	[85% per ASTM D1557] [82% per ASTM D698]	-2 to +3% of optimum

3.5 FIELD QUALITY CONTROL

- A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA standards 29 CFR Part 1926.650 Subpart P, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.
- B. Responsibilities of Special Inspector:
 1. Review proposed materials for fill and backfill around structures.
 2. All testing, observation and work indicated as being performed by the Geotechnical Engineer in Article 3.5 of this Specification Section.
 3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.

5. Extent of compaction testing will be as necessary to assure compliance with specifications.
 6. Prepare and submit inspection and test reports to Engineer.
 - a. Coordinate such work with other Special Inspectors.
 7. Test reports to include the following:
 - a. Report and certification of aggregate fill and drainage fill.
 - b. Test reports on borrow material.
 - c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
 - d. Field reports; in-place soil density and moisture tests.
 - e. One optimum moisture-maximum density curve for each type of soil encountered.
 - f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 - g. Other documentation necessary for Geotechnical Engineer to approve earthwork.
 - h. Assist Engineer to determine corrective measures necessary for defective work.
- C. Responsibilities of Testing Agency for Excavation and Backfilling:
1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.5 of this Specification Section.
 2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 3. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
 4. Extent of compaction testing will be as necessary to assure compliance with specifications.

END OF SECTION

SECTION 31 23 33
TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Excavation, trenching, backfilling and compacting for all underground utilities.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - 2. Division 26 - Electrical.
 - 3. Section 31 23 00 - Earthwork.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³ (600 kN-M/M³)).
 - b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - c. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- B. Qualifications: Hire an independent soils laboratory to conduct in-place moisture-density tests for backfilling to assure that all work complies with this Specification Section.

1.3 DEFINITIONS

- A. Excavation: All excavation will be defined as unclassified.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 2. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.
 - 3. Submit sieve analysis reports on all granular materials.
- B. Informational Submittals:
 - 1. Trench shield (trench box) certification if employed:
 - a. Specific to Project conditions.
 - b. Re-certified if members become distressed.
 - c. Certification by registered professional structural engineer, registered in the state where the Project is located.
 - d. Engineer is not responsible to, and will not, review and approve.

1.5 SITE CONDITIONS

- A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.
 - 1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.
- B. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.

- C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.
- D. Verify location of existing underground utilities

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill Material:
 - 1. As approved by Owner.
 - a. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
 - b. Moisture content at time of placement: $\pm 3\%$ of optimum moisture content as specified in accordance with ASTM D698.
 - 2. Gravel trench backfill materials:
 - a. Uniformly graded pea gravel defined below:
- B. Subgrade Stabilization Materials: Provide subgrade stabilization material
- C. Bedding Materials:
 - 1. As approved by the Geotechnical Engineer.
 - 2. Granular bedding materials:
 - a. ASTM D2321 Class 1B.
 - 1) Well-graded crushed stone.

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and dispose of unsuitable materials as directed by Geotechnical Engineer to site provided by Contractor.

3.2 EXCAVATION

- A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by Geotechnical Engineer.
- B. Excavation for Appurtenances:
 - 1. 12 IN (minimum) clear distance between outer surface and embankment.
- C. Groundwater Dewatering:
 - 1. Where groundwater is, or is expected to be, encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade to allow subgrade stabilization, pipe, bedding and backfill material to be placed in the dry, and to maintain a stable trench wall or side slope.
 - 2. Groundwater shall be drawn down and maintained at least 3 FT below the bottom of any trench or manhole excavation prior to excavation.
 - 3. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
 - a. Employ dewatering specialist for selecting and operating dewatering system.
 - 4. Keep dewatering system in operation until dead load of pipe, structure and backfill exceeds possible buoyant uplift force on pipe or structure.
 - 5. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
 - 6. Install groundwater monitoring wells as necessary.
 - 7. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.

8. Cost of groundwater dewatering shall be included in the lineal foot unit price of the pipe installation] [compensated under an allowance.
- D. Trench Excavation:
1. Excavate trenches by open cut method to depth shown on Drawings and necessary to accommodate work.
 - a. Support existing utility lines [and yard piping] where proposed work crosses at a lower elevation.
 - 1) Stabilize excavation to prevent undermining of existing utility and yard piping.
 2. Open trench outside buildings, units, and structures:
 - a. No more than the distance between two manholes, structures, units, or 300 LF, whichever is less.
 - b. Field adjust limitations as weather conditions dictate.
 3. Trenching within buildings, units, or structures:
 - a. No more than 100 LF at any one time.
 4. Any trench or portion of trench, which is opened and remains idle for seven calendar days, or longer, as determined by the Owner, may be directed to be immediately refilled, without completion of work, at no additional cost to Owner.
 - a. Said trench may not be reopened until Owner is satisfied that work associated with trench will be prosecuted with dispatch.
 5. Observe following trenching criteria:
 - a. Trench size:
 - 1) Excavate width to accommodate free working space.
 - 2) Cut trench walls vertically from bottom of trench to 1 FT above top of pipe, conduit, or utility service.
 - 3) Keep trenches free of surface water runoff.
 - a) Include cost in Bid.
 - b) No separate payment for surface water runoff pumping will be made.
- E. Trenching for Electrical Installations:
1. Observe the preceding Trench Excavation paragraph in PART 3 of this Specification Section.
 2. Modify for electrical installations as follows:
 - a. Open no more than 600 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
 - b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
 - c. Do not over excavate trench.
 - d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
 - e. See Division 26 for additional requirements.
- F. Flowable Fill:
1. Flowable fill shall be:
 - a. Discharged from a mixer by any means acceptable to the Engineer into the area to be filled.
 - b. Placed in 4 FT maximum lifts to the elevations indicated.
 - 1) Allow 12 HR set-up time before placing next lift or as approved by the Engineer.
 - 2) Place flowable fill lifts in such a manner as to prevent flotation of the pipe.
 2. Flowable fill shall not be placed on frozen ground.
 3. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
 4. Flowable fill batching, mixing, and placing may be started if weather conditions are favorable, and the air temperature is 34 DEGF and rising.
 5. At the time of placement, flowable fill must have a temperature of at least 40 DEGF.
 6. Mixing and placing shall stop when the air temperature is 38 DEGF or less and falling.

7. Each filling stage shall be as continuous an operation as is practicable.
8. Prevent traffic contact with flowable fill for at least 24 HRS after placement or until flowable fill is hard enough to prevent rutting by construction equipment.
9. Flowable fill shall not be placed until water has been controlled or groundwater level has been lowered in conformance with the requirements of the preceding Groundwater Dewatering paragraph in PART 3 of this Specification Section.

3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

- A. Over-Excavation:
 1. Backfill and compact to 90% of maximum dry density per ASTM D698.
 2. Backfill with granular bedding material as option.
- B. Rock Excavation:
 1. Excavate minimum of 6 IN below bottom exterior surface of the pipe or conduit.
 2. Backfill to grade with suitable earth or granular material.
 3. Form bell holes in trench bottom.
- C. Subgrade Stabilization:
 1. Stabilize the subgrade when directed by the Owner.
 2. Observe the following requirements when unstable trench bottom materials are encountered.
 - a. Notify Owner when unstable materials are encountered.
 - 1) Define by drawing station locations and limits.
 - b. Remove unstable trench bottom caused by Contractor failure to dewater, rainfall, or Contractor operations.
 - 1) Replace with subgrade stabilization with no additional compensation.

3.4 BACKFILLING METHODS

- A. Do not backfill until tests to be performed on system show system is in full compliance with specified requirements.
- B. Carefully Compacted Backfill:
 1. Furnish where indicated on Drawings, specified for trench embedment conditions and for compacted backfill conditions up to 12 IN above top of pipe or conduit.
 2. Comply with the following:
 - a. Place backfill in lifts not exceeding 8 IN (loose thickness).
 - b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
 - c. Observe specific manufacturer's recommendations regarding backfilling and compaction.
 - d. Compact each lift to specified requirements.
- C. Common Trench Backfill:
 1. Perform in accordance with the following:
 - a. Place backfill in lift thicknesses capable of being compacted to densities specified.
 - b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
 - c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
- D. Water flushing for consolidation is not permitted.
- E. Backfilling for Electrical Installations:
 1. Observe the preceding Carefully Compacted Backfill paragraph or Common Trench Backfill paragraph in PART 3 of this Specification Section or when approved by the Engineer.
 2. Modify for electrical installation as follows:
 - a. Observe notes and details on electrical drawings for fill in immediate vicinity of direct burial cables.

3.5 COMPACTION

A. General:

1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
2. In no case shall degree of compaction below minimum compactions specified be accepted.

B. Compaction Requirements:

1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.
 - a. Bedding material:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	[75]% relative density by ASTM D4253 and ASTM D4254

b. Carefully compacted backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All applicable areas	Cohesive soils	95% of maximum dry density by ASTM D698
	Cohesionless soils	[75]% relative density by ASTM D4253 and ASTM D4254

c. Toe drain bedding and backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	60% relative density by ASTM D4253 and ASTM D4254

d. Common trench backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
Under pavements, roadways, surfaces within highway right-of-ways	Cohesive soils	95% of maximum dry density by ASTM D698
	Cohesionless soils	[60]% of relative density by ASTM D4253 and ASTM D4254
Under turfed, sodded, plant seeded, nontraffic areas	Cohesive soils	85% of maximum dry density by ATM D698
	Cohesionless soils	[40]% of relative density by ASTM D4253 and ASTM D4254

3.6 FIELD QUALITY CONTROL

A. Testing:

1. Perform in-place moisture-density tests as directed by the Owner.
2. Perform tests through recognized testing laboratory approved by Owner.
3. Costs of "Passing" tests paid by Owner.
4. Perform additional tests as directed until compaction meets or exceeds requirements.
5. Cost associated with "Failing" tests shall be paid by Contractor.
6. Reference to Engineer in this Specification Section will imply Geotechnical Engineer when employed by Owner and directed by Engineer to undertake necessary inspections as approvals as necessary.

7. Assure Owner has immediate access for testing of all soils related work.
8. Ensure excavations are safe for testing personnel.

END OF SECTION